Summer 8-20-2021

A Quantitative Study of Mathematics Anxiety in First-Generation Pre-Service Teachers

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A QUANTITATIVE STUDY OF MATHEMATICS ANXIETY IN FIRST-GENERATION PRE-SERVICE TEACHERS

By

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A DISSERTATION

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

(in Educational Leadership)

The Graduate School

The University of Maine

August 2021

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Dissertation Advisor: Dr. Richard Ackerman

An Abstract of the Dissertation
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Many pre-service teachers suffer from mathematics anxiety which can lead to mathematics avoidance, poor mathematics performance, and the potential to pass on mathematics anxiety to their future students. More and more first-generation college students, who also suffer from math anxiety, are attending four-year universities and studying to be teachers. School leaders, educators, and researchers must recognize the serious nature of mathematics anxiety, how it negatively impacts learners, and how the cycle is perpetuated if the root causes of mathematics anxiety are not mitigated, especially in elementary teachers.

This quantitative study, which utilized an anonymous mathematics anxiety survey, examined the prevalence of math anxiety in first-generation pre-service elementary teachers matriculated in Elementary Education programs at University of Maine System (UMS) campuses. The goal was to determine whether there is disparity between first-generation college students and their non-first-generation peers, as well as whether mathematics anxiety and/or

first-generation student status is impacted by perceived access to social capital and/or parent education.

The most important finding of this study was that pre-service teachers who are first-generation college students have no more mathematics anxiety than their non-first-generation peers. Although both groups of pre-service teachers reported more anxiety when being tested in mathematics than when learning mathematics, there was no significant generational difference in either learning or testing anxiety scores. There was also no statistically significant difference between mathematics anxiety scores of pre-service teachers whose parents had less than a two-year college degree and their peers whose parents had at least a two-year degree. Another important finding was that first-generation students' perceived access to social capital was not less than their non-first-generation peers' perceived access. Although access to social capital, especially access regarding university supports, significantly impacted mathematics anxiety, there was no generational significance. Additionally, most UMS pre-service teachers reported having access to social capital.

These findings suggest the need for continued resources and supports for all UMS pre-service teachers as well as considering additional mathematics resources to help mitigate the anxiety many experience.

DEDICATION

In memory of my dad, Bucky Webber, who was my biggest cheerleader, my greatest fan, and who believed there was nothing I couldn't accomplish. I love you and miss you more than words can express. This one's for you, Dad. <3

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to my committee members. I am incredibly thankful for the knowledge and wisdom I have gained from each member, as well as the continuous support and encouragement I've received throughout this process.

Dr. Richard Ackerman, it's been almost 14 years since we first met at the beginning of my Master's level coursework. You have been an unwavering support to me since that time, and I've always appreciated your sincere pep talks and pearls of wisdom. I think of you every time I read a meaningful piece of poetry and carry with me the caring and insightful manner with which you view the world. I know you were hesitant to accept the role as my dissertation advisor due to your phased retirement, but I am so very thankful you stayed with me to the end. "Thank you" doesn't adequately express my gratitude.

Dr. Catherine Biddle, I thoroughly enjoyed each of the classes I had with you and especially appreciated your love of learning and people, and your desire to make the world a better place. I've learned much from you regarding research and writing and will always fondly remember the time we spent together, as well as your sound feedback and advice. Thank you for your ongoing encouragement and support over the last several years.

Dr. Craig Mason, words can't express how much I've learned from you and how much I've appreciated your style of teaching. You pushed me to learn while walking beside me to make sure I knew you were right there if I needed you. Your love of data is inspiring, and I've so enjoyed our analysis talks that made time fly. It's been a difficult year for your family, and I am so very appreciative you continued to work with me as I completed this chapter in my life. I truly couldn't have done this without you and am forever grateful for your expertise and encouragement.

Dr. Maria Frankland, I have referred to you as my Doctoral BFF from the very beginning of this journey. You never cease to amaze me with your intelligence and insight, and I am so thankful I've had you beside me for the past five years. Your feedback, support, encouragement, and friendship have been invaluable gifts for which I am incredibly grateful. We said we would do this together, and your membership on my dissertation committee is the perfect ending. Thank you for all of it - we will soon celebrate.

Dr. Allyson Dean, I am so glad Richard introduced us and suggested I ask you to be on my committee – thank you for agreeing to do so! I have appreciated your thoughtful feedback and encouragement as I've completed my final chapters and regret that we've never been able to meet in person. Thank you, and I hope we get the chance to meet in the near future.

I would also like to thank my family for their constant support and encouragement – especially when I felt like I was in over my head. You've served as my travel companions on the many, long road trips to Orono and patiently listened as I talked nonstop about my research and how exciting (and exhausting) it all was. You've offered technical assistance regularly and allowed me to hole up in my office for hours (sometimes days) without interruption as I completed various portions of my dissertation. Thank you for believing in me.

Most importantly, I want to acknowledge my Lord and Savior for providing this blessing and for placing amazing people in my path to support me along the way; none of this would have been possible without you.

I can do all things through Christ which strengthens me.

Philippians 4:13

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

As a university instructor teaching elementary mathematical methods courses to pre-service elementary teachers, I have observed negative feelings and avoidance of mathematics. My students report they often struggle in prerequisite college-level mathematics courses, further strengthening the fear they won't be effective mathematics educators. They admit to avoiding mathematics courses and only taking what is required for their degree due to their fear of failure. In my experience with these pre-service teachers in mathematics methods courses, I have witnessed their withdrawal and disengagement as a coping mechanism. They also share their worry that their students won't be successful in mathematical situations due to their influence; this worry strengthens their anxiety to a greater degree.

Other aspects of students' identities may exacerbate their mathematics anxiety. For example, as a first-generation college student, I can identify with the struggles many students face. Although my parents were supportive and encouraged me to attend college, they were very unfamiliar with the system and were unable to provide the assistance many of my peers took for granted. I remember working several jobs, having little time for social campus events, and feeling isolated in figuring things out on my own. As a first-generation college student, I lacked the social capital many of my peers took for granted.

The combination of the already prevalent persistence of elementary school teachers with mathematics anxiety and the struggles first-generation college students typically face presents a very real concern for our elementary students as they attempt to learn mathematics from a teacher who has mathematics anxiety.

This study explored the incidence of mathematics anxiety in first-generation college students who are studying to be teachers across the University of Maine campuses. In this chapter, I will outline the problem and then share the purpose of my study to include my research questions and inquiry method. I will conclude the chapter with a discussion of the significance of my research as it applies to teacher leaders and school administrators.

The Problem

Pre-service elementary teachers enter college less prepared for post-secondary education and are more likely to suffer from mathematics anxiety than their peers (Gonzalez-DeHass et al., 2017; Van der Sandt & Obrien, 2017). They also have limited mathematics understanding and avoid mathematical situations when possible (Wilson, 2013). Students with mathematics anxiety (in general) struggle in college level math classes (Woodard, 2004). They spend less time on mathematics instruction in their future classrooms than teachers who don't suffer from mathematics anxiety and also include the use of manipulatives and promote conceptual understanding to a lesser degree (Lake & Kelly, 2014). A study by Brady and Bowd (2005) reported high levels of mathematics anxiety in both U.S. and Canadian elementary school teachers.

This mathematics anxiety cycle has negative implications for teachers who experience mathematics anxiety, their students, and their students' mathematics performance. Literature indicates there is a negative correlation between mathematics anxiety and academic success in mathematics (Ashcraft & Krause, 2007; Novak & Tassell, 2017; Woodard, 2004) and that stereotype threat toward females, in particular, impacts students' mathematics performance and learning (Rydell et al., 2010; Steele, 1997; Tiedemann, 2000). This is worrisome due to the

National Education Association's report in 2010 that found that more than 70 percent of elementary teachers are female (National Education Association, 2010).

In addition to the prevalence of math anxiety in pre-service teachers, students who enter college with low mathematics scores (based on high school assessments, entrance exams, etc.) are often first-generation college students (Bailey et al. 2005). First-generation college students are more likely to have weaker skills in math and are less likely to experience success and persist in college than their non-first-generation peers (Terenzini et al., 1996). These students are also less likely (27% vs. 43%) to take upper-level math courses such as trigonometry, statistics, and pre-calculus in high school (Cataldi et al., 2018) which could strengthen their math skills and confidence. First generation college students also experience more stress when completing math work than their non-first-generation peers (Carpenter & Clayton, 2014) and have less access to social capital and the necessary resources they require for success (Moschetti & Hudley, 2015; Soria & Stebleton, 2013). When these factors are combined with the already prevalent mathematics anxiety many pre-service teachers experience, it presents an even larger problem with which to contend.

School leaders, educators, and researchers must recognize the serious nature of mathematics anxiety, how it negatively impacts our learners, and how the cycle is perpetuated if the root causes of the mathematics anxiety are not mitigated, especially in our elementary teachers. Mathematics anxiety can be crippling for students who struggle to pass mathematics courses and state assessments, and it can become a much larger problem when the mathematics teachers in our elementary schools suffer from mathematics anxiety. If pre-service teachers suffer from mathematics anxiety, the cycle not only continues but is exacerbated. Students with teachers who suffer from mathematics anxiety experience lower mathematics performance which can lead to mathematics anxiety (Cook & Hurst, 2013; Beilock et al., 2009; Gleason, 2013; Ramirez, et al., 2018), causing the cycle to continue.

Atherton (2014) found that first-generation college students score 20%-38% lower on the mathematics section of the SAT. In addition, according to the Congressional Budget Office (2011) the number of first-generation low-income students continues to increase due to the wealth gap between the rich and poor. Based on this information, first-generation college students are likely to suffer from mathematics anxiety to a greater degree than their non-first-generation peers and will account for a growing number of future teachers in our schools.

In light of the prevalence of math anxiety in pre-service teachers and the fact that first-generation college students often struggle with math, it would stand to reason that the prevalence of math anxiety in first generation pre-service teachers would be higher than their non-first-generation peers. Math anxiety needs to be identified, addressed, and mitigated to the greatest degree possible in order to break this cycle.

Purpose

This study examined the prevalence of math anxiety in first-generation pre-service elementary teachers matriculated in Elementary Education programs at University of Maine System campuses. The goal was to determine whether there is a disparity between first-generation college students and their non-first-generation peers, as well as whether their mathematics anxiety and/or first-generation student status is impacted by their perceived access to social capital and/or parent education. This study explored the questions as to whether or not gender, ethnicity, age, and prior math experiences impact these students' math anxiety scores. Also of interest was whether students' mathematics anxiety is impacted by the campus in which they are enrolled - whether the size/location of the campus and/or student demographics/profiles impact the prevalence of math anxiety in pre-service teachers.

Research Questions

1. Do first-generation college students matriculated in Education programs at University of Maine System campuses suffer from math anxiety to a greater degree than their non-first-generation peers?
2. Does the first-generation college student math anxiety score effect vary based on perceived access to social capital?
3. Does the first-generation college student math anxiety score effect vary based on level of parent education?

Significance of the Study

Given the problem, this study uses relevant literature to set the stage for studying current quantitative data through surveying Education students enrolled in University of Maine System universities. While there are many studies that indicate the prevalence of mathematics anxiety in pre-service teachers, there is limited information on mathematics anxiety in pre-service teachers who are first-generation college students. The apparent gap in the literature surrounding first-generation pre-service teachers may be an important key in beginning to break the mathematics anxiety cycle.

CHAPTER 2: REVIEW OF RELEVANT LITERATURE

In this chapter, I will review relevant literature to set the stage for my study on math anxiety in pre-service teachers who are also first-generation college students. The following sections point to my conceptual framework and the rationale for this study. I believe math anxiety is related to mathematics self-efficacy, theories of intelligence, gender, stereotype threat, first-generation college status, and social capital. I refer to research supporting this belief in each section of the literature review.

Mathematics Anxiety

Mathematics anxiety can be defined as "a feeling of tension, apprehension, or fear that interferes with mathematical performance" (Ashcraft, 2002, p. 181). It has also been described as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p. 551), and discomfort with any situation involving interaction with mathematics (Legg & Locker, 2009). Lyons and Beilock (2012) describe mathematics anxiety as being a phobia that produces negative emotional responses, while Buscal & Paznokas (2006) found that avoidance of mathematics contributes to a lack of understanding due to anxiety. Mathematics anxiety could also be described as an association between mathematics and the expectancy of failure, wherein the fear of failure is what triggers the anxiety (Pekrun, 2006).

Even the anticipation of mathematics experiences may cause mathematics anxious individuals to experience a neural pain response (Lyons & Beilock, 2012). In addition, when highly mathematics anxious students are completing math problems, they experience greater activity in the amygdala, which can negatively impact their working memory capacity, further decreasing their mathematics performance (Young et al., 2012). The Young et al. MRI study of

7-9-year-olds also indicated reduced activity in posterior parietal and dorsolateral prefrontal cortex regions, which are crucial for mathematical reasoning and can inhibit students' ability to perform in mathematical situations. In a recent electroencephalogram study, Klados et al. (2017) explored the differences in cortical networks between university students with low and high mathematics anxiety and found differences in both integration and segregation prior to mathematical work, which indicates that anticipatory anxiety negatively impacts mathematics-anxious learners when confronted with mathematics. In order to be successful in mathematical situations, learners need to be able to access their working memory resources, which may be compromised due to having to regulate their emotional reactions to mathematics anxiety (Rubinsten & Tannock, 2010). The results of this study indicate that arithmetic, emotions, and low achievement in mathematics are directly related.

While an older study by Ashcraft (2002) found that approximately 20% of students experience high mathematics anxiety, Beilock and Willingham (2014) found that nearly 50% of first and second grade students report having medium to high levels of mathematics anxiety and that 25% of students who attend four-year colleges report the same. In a recent study of secondary students, Schmitz et al. (2019) found higher mathematics-anxiety associations than mathematics-calmness associations and that mathemtical associations develop from a young age. Lindskog et al. (2017) found that mathematics anxiety is negatively correlated with mathematical performance and can potentially have life-long consequences for individuals to include negative affect and tension when confronted with mathematical problems.

According to data from the Program for International Student Assessment (PISA), mathematics anxiety is negatively related to poor mathematical performance in fifteen-year-olds. In 2012, 63 out of 64 educational systems reported students with higher levels of mathematics anxiety experienced lower levels of mathematical performance. Data also indicated countries with higher levels of mathematical performance had students with lower levels of mathematics anxiety (OECD, 2013). Interestingly, mathematics anxiety is specific to mathematical situations and performance (not necessarily test anxiety, in general) and doesn't necessarily imply anxiety in other content areas (Lyons & Beilock, 2012). Maloney, et al. (2015) found that students of mathematics anxious parents (who helped their children with homework) experienced decreased mathematics scores at the end of the year, while their reading scores were not impacted, indicating that mathematics anxiety is specific to mathematical experiences. Also of interest is that the highest achieving (90th percentile) students are more impacted by mathematics anxiety than their lower-achieving (10th percentile) peers (OECD, 2013).

These descriptions of mathematics anxiety and its effects encompass much of what is felt by many mathematics anxious pre-service teachers enrolled in education courses (Gonzalez-DeHass et al., 2017; Van der Sandt & Obrien, 2017). The mathematics anxiety they face is likely compounded by their fear of teaching mathematics and passing their anxiety on to their future students.

Mathematics Self-Efficacy

Research indicates these fears are warranted as mathematics anxiety or low self-efficacy (judgment of one's capabilities) beliefs can act as barriers to effective mathematics instruction, which can negatively impact the achievement and beliefs of students with mathematics anxious teachers (Itter & Meyers, 2017; Looney et al., 2017; Mensah, 2013; Swars et al., 2010). These mathematics anxious teachers are more likely to teach in ways that increase the development of mathematics anxiety in their students (Bekdemir, 2010; Whyte & Anthony, 2012). They lack the confidence necessary to teach in ways that support students' conceptual understanding of mathematics, as well as their positive mathematics attitudes and beliefs (Zoo & Koomen, 20016). Kelly, et al. (2020) found that instructors can indirectly contribute to their students' mathematics anxiety and that psychological distance between students and teachers is increased by teachers' mathematics behaviors.

Bandura's (1993) theory on self-efficacy indicates the higher one's self-appraisal of capability, the higher the goals they set for themselves. In a study of fifth grade students, a negative correlation was found between students' mathematics self-efficacy and mathematics anxiety; higher anxiety resulted in lower self-efficacy (Griggs et al., 2013). Huang et al. (2019) also found a significant negative correlation between mathematics self-efficacy and mathematics anxiety for both boys and girls. Based on the negative reactions experienced by individuals with low mathematics self-efficacy, it's not surprising that a common response is to avoid mathematics (Zeldin, Britner, & Pajares, 2008).

Self-concept (general perception of self) can also impact mathematics anxiety. Almed et al. (2012) found a dynamic reciprocal relationship between self-concept and mathematics anxiety in that low mathematics self-concept levels predict higher levels of mathematics anxiety and that high levels of mathematics anxiety predict lower self-concept levels. This study also indicates that self-concept affects anxiety twice as much as anxiety affects self-concept.

Together, these studies suggest that early negative experiences with mathematics can have long-term and ongoing negative effects on both an individual's self-efficacy and self-concept, which can contribute to mathematics anxiety.

Theories of Intelligence

Individuals with a growth mindset believe a particular attribute such as intelligence can grow, develop, and improve over time, while those with a fixed mindset believe their skills, talents and abilities don't change, regardless of their efforts (Dweck, 2008). Implicit theories of intelligence suggest that growth mindset as opposed to fixed mindset can impact students' self-efficacy, which in turn, can impact their mathematics anxiety. A positive correlation between students with a growth mindset and their self-efficacy was found in a study of students in grades 4-6 (Abdullah, 2008). In a more recent study on 7th graders, Huang et al. (2019) found that comparatively, boys report a higher growth mindset and lower mathematics anxiety and girls report a lower growth mindset and higher mathematics anxiety. In addition, there was a positive correlation between mathematics self-efficacy and growth mindset for boys, but there was no such correlation for girls. College students with a fixed mindset are more likely to feel helpless and experience decreased self-efficacy when faced with difficult challenges as compared to their peers with a growth mindset (Davis et al., 2011). These studies suggest that a fixed mindset can negatively impact students' self-efficacy and can indirectly impact their feelings toward mathematics, in both learning and teaching capacities. If students and teachers believe they "aren't good at mathematics" and don't have the ability to improve, it is unlikely that they will be successful in mathematical situations.

This may be illustrated in teachers who have high levels of mathematics anxiety and therefore have lowered confidence in their ability to teach mathematics (Swars et al., 2010; Wilson, 2013). Teacher engagement and mathematics instruction practices are negatively impacted by teachers who suffer from mathematics anxiety and have low efficacy beliefs regarding their ability to teach mathematics (Wilson, 2013). They can actually project their own mathematics anxiety on to the mathematical expectations they have for their students (Mizala et al., 2015), especially girls (Beilock et all, 2009).

Girls and Mathematics

An overwhelming number of pre-service elementary teachers are women (National Education Association, 2010). This is important to note because girls, in particular, are negatively influenced and impacted by negative mathematics gender stereotypes (Beilock et al., 2009) and suffer from mathematics anxiety to a greater degree than their male counterparts; 56 of the 64 countries that participated in the Program for International Student Assessment (PISA) reported this disparity (OECD, 2013). Girls report higher mathematics anxiety and have stronger negative feelings toward mathematics than their male counterparts and are more likely to choose lower difficulty level mathematics (Schmitz et al., 2019). Cvencek, et al. (2011) report a stronger association between elementary-aged boys and mathematics, as well as a stronger association between self and mathematics, compared to their elementary-aged female peers.

In a recent study of second and fourth grade children, Van Mier et al. (2019) found that a positive correlation between mathematics anxiety and mathematics performance was only evident in girls and that there were significant differences between boys' and girls' mathematics performance, especially in the second graders. Interestingly, this study indicated that although there wasn't a significant difference between boys' and girls' mathematics anxiety, girls were significantly more affected by the anxiety regarding their mathematics performance.

Female students had lower mathematics scores at the end of the school year (compared to the beginning of the school year) when their teacher suffered from mathematics anxiety and believed in traditional stereotypes - boys are good in mathematics while girls are good at reading (Beilock et al., 2009). This was also indicated in a report by the NEA (National Teachers Association, 2003). Children do not need to be explicitly told that boys are good in mathematics and girls are not; they can pick up cues and develop negative mathematics-gendered stereotypes based on the implicit behaviors of the adults around them. Stereotypes can be transmitted in a variety of ways from both parents and teachers to include viewing nonverbal behaviors (Weisbuch et all, 2009) and perceiving nonverbal cues (Fluck et al., 2001). This can contribute to the debilitating effects of mathematics anxiety in our elementary teachers and students.

Gendered mathematics attitudes can lead to mathematics avoidance (Blackwell et al., 2007) which can lead to increased mathematics anxiety in girls. This becomes even more problematic because of the disproportionate number of females who enroll in Education programs. The majority of elementary education majors are female and indicate higher levels of mathematics anxiety than any other college major (Ramirez, et al., 2018; Van der Sandt & Obrien, 2017). When pre-service teachers are anxious about their performance and abilities in mathematics, it is likely they will struggle in mathematics and inadvertently pass this anxiety on to their future students (Beilock et al., 2009; Mizala et al., 2015; Ramirez, et al., 2018). It does not need to be intentional in order for mathematics anxiety to be perceived and transmitted. How teachers feel about mathematics impacts the appropriateness of their instruction, as well as their expectations of students (Lake & Kelly, 2014; Beilock et al., 2009; Mizala et al., 2015; Swars et al., 2010). Limited time spent on mathematics instruction as well as lowered expectations (Lake & Kelly, 2014), can negatively impact students' growth and feelings about mathematics, especially female students. This is problematic for both students and teachers as we consider the implications of mathematics anxiety and its cyclical nature.

Stereotype Threat

Stereotype threat can be defined as "a situational threat – a threat in the air – that, in general form, can affect the members of any group about whom a negative stereotype exists"

(Steele, 1997, p. 614). Teachers who believe girls are not good at mathematics (perhaps because they, themselves, are female and have mathematics anxiety) may be at risk of stereotype threat impacting their female students' mathematical performance. Tiedemann (2000) found that students' previous grades and teachers' perceptions of their abilities strongly impacted students' mathematics grades and that teachers expected boys to perform better than girls in mathematics, as well as believe mathematics is more difficult for girls. Cvencek et al. (2011) found that even children, ages 6 to 11, hold the belief that boys are better in mathematics than their female counterparts, and Flore & Wicherts (2015) found that girls underperform on tests, due to stereotype threat. In a recent study of college women, Perez-Garen et al. (2017) found that stereotype threat has a negative effect on female mathematical performance and that this effect is greater for those with mathematics anxiety.

Shapiro and Williams (2011) found that girls' mathematical performance can suffer from negative mathematics-gendered stereotypes, even if they don't subscribe to those stereotypes, themselves. Stereotype threat not only impacts achievement on academic tasks, but also impacts learning, itself (Rydell et al., 2010) which can further inhibit mathematical comprehension.

One study indicated that preservice teachers are perceived as having low-level competence and that they perform more poorly on cognitive tests than other majors when subjected to stereotype threat (Ihme & Moller, 2015). Keller & Dauenheimer (2003) affirmed that reducing stereotype threats led to increased performance in stigmatized group members (females/mathematics).

These studies demonstrate the impact stereotype threat can have on mathematics anxiety in learners (especially girls) which can be further complicated by preservice teachers (likely female) who are first-generation college students and may already have limited resources and self-efficacy beliefs.

First-Generation College Students

First-generation college students (FGCS) have been defined in different ways in literature (Spiegler & Bednarak, 2013), such as parents with no college education (Ishitani, 2006), or parents with some education, but not a four-year degree (McCarron & Inkelas, 2006). For the purposes of this study, first-generation college status will be defined as those students whose parents did not obtain a four-year degree. Although first-generation college students have typically gravitated toward 2-year colleges, many are now enrolling in 4-year universities (Gallavan & Benson, 2014). FGC students are faced with emotional and financial difficulties as well as academic and social challenges (Lightweis, 2014) which place additional strain on students and end up impacting their academic performance.

Parents of FGCS are less likely to encourage their children to take Algebra in eighth grade (31%), as compared to their non-FGCS parent peers (53%) (Horn & Nunez, 2000). In addition to this, first-generation parents are less likely to have knowledge of college environments and/or place value on a college degree (McConnell, 2000) when compared to their peers. FGC students report experiencing a lack of finances and information on college applications, financial aid, FAFSA, etc. as well as difficulty in adjusting to college life and to the academic demands of college (Gibbons et al., 2019).

The demographic difference between many first-generation college students and their non-first-generation peers creates a resource disparity (McCarron & Inkelas, 2006) and further challenges their opportunity to achieve and succeed. Although not true of all first-generation college students, many face economic hardships. Engle and Tinto (2008) reported that 24% of all undergraduate college students in the United States were first-generation and low-income students in 2008; Horn & Nunez (2000) report that over one quarter (27%) of traditional-aged college students are FGCS and that half of them are from low-income families. This rise in FGCS is promising but also underscores the importance of recognizing their unique needs.

The financial concerns first-generation college students face create a major source of stress when paying for college is their responsibility (Engle & Tinto, 2008; Chang et al., 2019). Even when their parents are able to help support them, they experience feelings of guilt knowing their parents are burdened with the financial responsibilities of college (Chang et al., 2019). An additional challenge for these students is navigating the financial aid process when parents have no or little knowledge or experience in this area (Chang et al. 2019).

First-generation college students are more likely to have lower SAT scores (Atherton, 2014; Hicks, 2003) and grade point averages (Chen, 2005; Hicks, 2003; Lee et al., 2004), take fewer upper-level mathematics courses (Chen, 2005), and also have lower levels of support from their families (Hicks, 2003; Thayer, 2000). Horn & Nunez (2000) found that only 63% of FGCS have completed an upper-level mathematics course, as compared to 83% of their non-first-generation peers. The U. S. Department of Education (2018) also reported that FGCS are less likely to take high level mathematics courses than their peers: trigonometry/statistics/precalculus (27% vs 43%), calculus (7% vs 22%), and Advanced Placement courses (18% vs 44%). Beilock and Willingham (2014) also found that 80% of community college students suffer from mathematics anxiety, which supports the idea that first-generation college students (regardless of their college affiliation) may, in fact, suffer from mathematics anxiety to a greater degree than their non-first-generation peers.

Maloney, et al. (2015) found that mathematical-anxious parents are more likely to increase mathematics anxiety in their early elementary aged children as well as negatively impact their growth in mathematics when they support them by helping with mathematics homework. Suarez-Pellicioni, et al. (2016) also found that parents can negatively impact their children's attitudes toward mathematics. This may very well be the case with first-generation students and implies that even when parents are attempting to support their children, they may be unintentionally passing the mathematics anxiety on by exposing them to their own mathematics anxiety. These kinds of challenges put first-generation college students at a disadvantage when compared to their non-first-generation peers who are more likely to focus on schoolwork, access resources when necessary, and experience adequate financial and academic support at home. This impacts our pre-service teacher education programs in that many teacher candidates are female first-generation college students and are limited in universal knowledge (Gallavan & Benson, 2014).

Social Capital/Demographics

Social capital can be described as the value of networks and relationships that offer support or assistance in various social situations (Stanton-Salazar, 2001). It has also been described as resources such as social support, social credentials, and information channels that are available through social connections (Villalonga-Olives, Adams, & Kawachi, 2016). Access to social capital can be measured by determining whether individuals can obtain valued resources outside of their social circle, participate in social events outside of their social circle, and trust others in their neighborhood, specifically authority figures (Villalonga-Olives, Adams, & Kawachi, 2016). Social capital can also be measured by ascertaining individuals' perception of connectedness and sharing within their communities, (Harpham, Grant, & Thomas, 2002).

Access to social capital is very important in the post-secondary success of first-generation college students (Kundu, 2017).

A study by Moschetti & Hudley (2015) indicates that first-generation, White, working-class college students report having limited educational support from their parents and are required to work extended hours (Chen, 2005; Lee et al., 2004), resulting in minimal time spent on campus. These students are more likely to suffer from lack of self-esteem and have dissimilar expectations of college than their non-first-generation peers (Hicks, 2003); they have greater obstacles to overcome in order to achieve success and feel less welcome on campus than their peers (Soria & Stebleton, 2013). They report questioning their sense of social and academic belonging when they compare themselves to their peers on campus (Mean & Pyne, 2017), and they report difficulty in finding peers to study with, faculty to talk to or receive help from, and navigating university life (Soria & Stebleton, 2013). Blake, Garriott, & Keene (2016) found that first-generation status is correlated to GPA and academic satisfaction.

First-generation college students typically believe their success and progress is limited to their own personal characteristics and aren't comfortable asking for assistance from their institutions (Moschetti & Hudley, 2005). They believe that have to figure everything out on their own (Glaessgen et al., 2018); self-reliance is their primary source of problem solving and struggling on their own is preferable to imposing on others, even when their coping mechanisms include distraction, disengagement, substance use, and avoidance (Chang et al, 2019). Means & Pyne (2017) found that first-generation college students experience a college education that is influenced by class privilege and don't want to bother or interrupt their busy faculty members; Chang et al. (2019) found FGCS underutilize both formal and informal sources of support and don't disclose their problems when confronted with difficulty due to the belief that disclosure will only makes things worse by burdening others and inviting judgment. This is unfortunate as Almeida et al. (2019) found that access to social capital via college faculty and staff positively impacts first-generation college students' grade point average.

Pascarella et al. (2004) found that first-generation college students who developed relationships with students who had college-educated parents experienced increased intellectual development and motivation; they were able to access social capital through their peers. First-generation college students who took part in an intervention to cultivate their social capital experienced improved attitudes and behaviors around seeking support from faculty and staff and earned higher grade point averages at the end of their first year (Schwartz et al., 2018).

Unfortunately, first-generation college students are less likely to develop these relationships to gain access to social capital (Cushman, 2007) and are forced to navigate the unfamiliar territory of college life on their own unless their university offers a first-year seminar to address some of these concerns. FGCS may lack the professional and/or career network that their peers enjoy (Tate et al., 2015). This may be due in part to their limited time spent on campus because of their work schedules and commuter and/or part-time status (Engle & Tinto, 2008). This problem is compounded in that these students are the ones who, in all likelihood, require more assistance than their non-first-generation peers (Padgett et al., 2012). The lack of social capital creates additional challenges such as a lowered confidence in their abilities and creates a sense of isolation for first- generation college students (Cushman, 2007). They are less likely to participate in clubs and organizations (Glaessgen et al., 2018; Pascarella et al., 2004) that can enhance their critical skills and knowledge which can positively impact their ownership and control of college success (Pascarella et al., 2004).

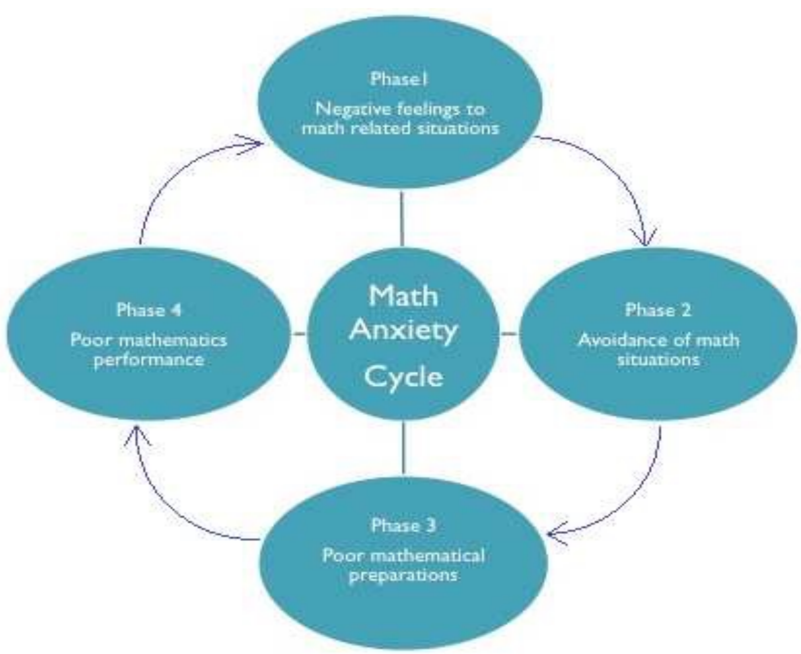
First-generation college students who are studying to be teachers have multiple disadvantages to overcome, have less social capital to rely upon, and are likely to suffer from mathematics anxiety to a greater degree than their non-first-generation peers. This phenomenon warrants research and attention from educational leaders at all levels.

A Conceptual Framework for Mathematics Anxiety in First-Generation Pre-Service Teachers

Mathematics Avoidance and Performance

Preis and Biggs (2001) described mathematics avoidance and performance as a cycle illustrated in Figure 1. This figure illustrates that the cycle has four phases and begins with negative feelings to mathematics related situations leading to students avoiding mathematics situations (Ashcraft & Krause, 2007; Cataldi et al., 2018). Because of this avoidance, students are poorly prepared in mathematics, which leads to poor mathematics performance (Ashcraft & Krause, 2007). This poor performance strengthens the negative feelings students already have towards mathematics, and the cycle continues. See Figure 1.

Figure 1. The cyclic nature of mathematics avoidance and mathematics performance



Previous studies have shown there is a cyclical nature to mathematics avoidance and mathematics performance, but the cycle may or may not start with Phase 1 (negative feelings toward mathematics related situations); the cycle can begin in any of the four phases (to include avoidance of math (Cataldi et al., 2018), poor mathematics preparation (Bryant, 2009), and poor mathematics performance (Ashcraft & Krause, 2007). Lack of conceptual mathematics performance, in particular, can also be at the root of poor mathematics performance and/or math anxiety (Lake & Kelly, 2014).

My experience with pre-service teachers in math methods courses suggests they are able to memorize formulas and algorithms but become anxious when asked to explain them due to their lack of conceptual knowledge. According to Carpenter & Clayton (2014), first-generation college students report feeling depressed and unable to think clearly when confronted with math work. Pre-service teachers, especially those who are first-generation college students, suffering from math anxiety may not have the conceptual knowledge and/or confidence necessary to make appropriate connections and applications, and this creates anxiety regarding their ability to teach mathematics concepts in their future classrooms (Boyd et al, 2014; Bryant, 2009). Gresham (2018) found that preservice teachers suffering from math anxiety still experienced math anxiety after teaching for five years, indicating the anxiety doesn’t subside with experience. According to the National Council of Teachers of Mathematics (2019), connecting the procedural elements of math topics to conceptual understanding is necessary for effective mathematics instruction. Teachers with math anxiety may not be prepared to engage in this type of instruction due to their own deficiencies.

I propose a revised model to describe contributors to math anxiety and how those contributors can translate into a cycle of teachers with math anxiety, especially those who are already disadvantaged due to their first-generation college student status.

Mathematics Anxiety Cycle

Mathematics anxiety often begins as a result of negative mathematics experiences (Stoehr, 2015). These experiences can be due to failure to perform well but also may be the result of experiences with mathematics instructors (Lee & Zeppelin, 2014; Sloan, 2010). Once those negative mathematics experiences occur, students sometimes find themselves avoiding mathematics in a variety of ways. They take fewer mathematics courses and/or participate less in the courses they do take (Ashcraft & Krause, 2007; Bryant, 2009). Mathematics avoidance leads to a lack of mathematics conceptual knowledge, and the knowledge students do have is focused more on rote memorization and limits their ability to problem solve and transfer learning to novel situations (Rayner et al., 2009). Students' lack of conceptual knowledge leads to poor mathematics performance; this poor performance leads back to negative mathematics experiences, and the mathematics anxiety cycle continues.

Mathematics Anxiety in Elementary Teachers

Of particular importance is how this cycle of mathematics anxiety continues through the practice of elementary school teachers, many who suffer from mathematics anxiety themselves. How teachers teach is impacted by their mathematics teaching anxiety (Haciomeroglu, 2014). Elementary school teachers who have a low self-concept regarding mathematics (due to negative experiences, mathematics avoidance, lack of conceptual knowledge, and poor mathematics performance) (Bryant, 2009) tend to spend less time on mathematics instruction in their classrooms and have lower mathematics expectations for their students (Mizala et al., 2015). If teachers are anxious about mathematics and spend less time teaching mathematics, their students are at a distinct disadvantage compared to their peers who do not have mathematics anxious teachers (Looney et al., 2017; Swars et al., 2010). Conceptual instruction takes more time than traditional mathematics instruction and requires skilled and confident teachers. Limited mathematics instruction does not lend itself to these time-intensive conceptual learning activities (Lake & Kelly, 2014), which means students are less likely to develop a solid conceptual understanding of mathematics principles; this limited conceptual understanding limits students' ability to perform well in class and on standardized tests which leads to negative mathematics experiences (Malinsky, et al, 2006; Ramirez et al, 2016). Bursal & Paznokas (2006) found that teachers with higher mathematics anxiety than their peers believe they will not be able to teach mathematics effectively. Not only does the cycle continue, but it perpetuates through the introduction of an increasing number of students (and future teachers) with mathematics anxiety (Beilock et al, 2009).

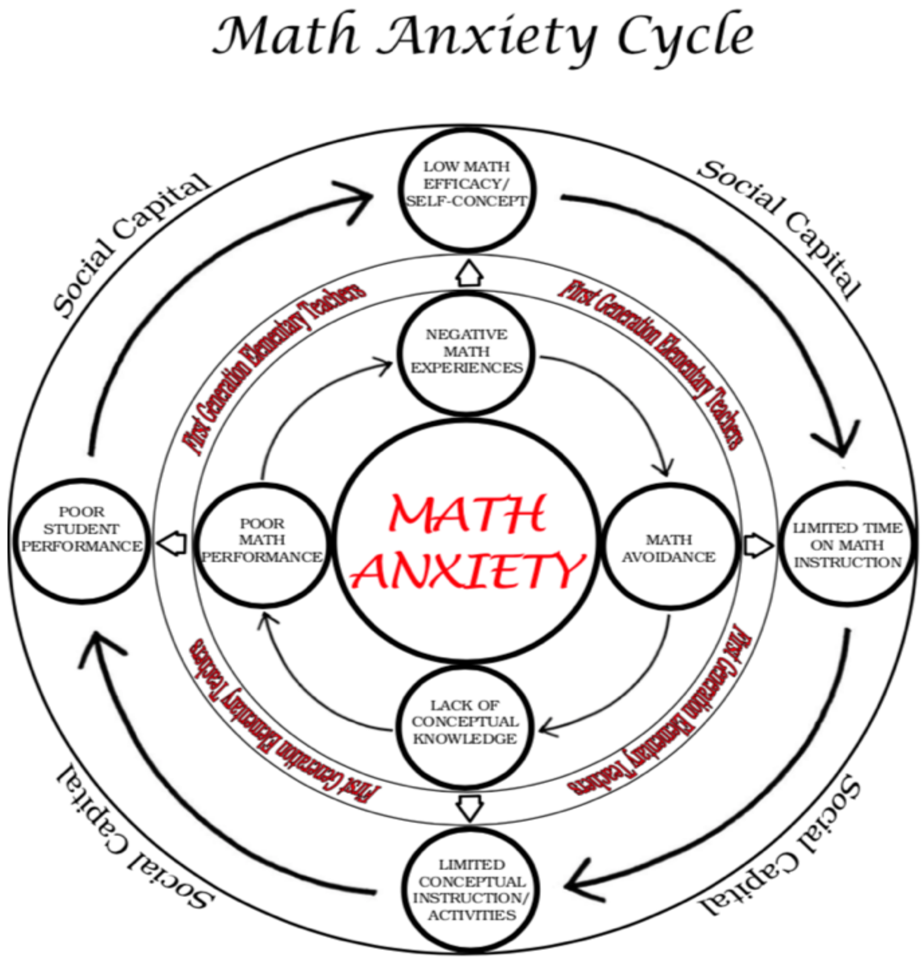
Mathematics Anxiety in First-Generation Elementary Teachers

While not all pre-service teachers described in this cycle may be first-generation college students, the cycle becomes more complex when that is the case. They have fewer resources to rely on and don't often have the self-confidence necessary to succeed (Hicks, 2003). Defreitas & Rinn (2013) found that first-generation students who score higher on mathematics self-concept scores are likely to experience higher mathematics achievement, and the opposite also holds true; individuals who suffer from mathematics anxiety likely find it difficult to increase their mathematics self-efficacy and continue to perform poorly in mathematics courses and on mathematics assessments. While this may not be unique to first-generation students, I suspect the struggles they face are compounded by other challenges FGCS face. Chen (2013) found that first-generation college students take fewer mathematics credits, particularly fewer advanced mathematics courses, in high school than their non-FGCS peers (Cataldi et al., 2018). First-generation parents are also likely to have mathematics anxiety and beliefs about girls and math that impact their children's attitudes (Gunderson et al., 2001). This math avoidance creates an additional disparity for first-generation college students and puts them at greater risk of developing or persisting in their mathematics anxiety.

Social Capital and First-Generation Teachers

The social capital surrounding this mathematics anxiety cycle that is available to many new teachers is often lacking for first-generation teachers. They may not feel comfortable asking for help (Moschetti & Hudley, 2005), and their families are likely unable to offer the support they need (Lee et al., 2004). While not all first-generation college students have parents who suffer from mathematics anxiety, it is plausible that they have less mathematics experience. One study found that parents' mathematics anxiety and attitudes transfer to their children which can cause increased mathematics anxiety and influence math achievement and performance in their children (Soni & Kumari, 2015). Without a healthy self-concept, sufficient mathematics coursework, and the social capital and resources necessary to succeed, I proposed that first-generation teachers are at higher risk of suffering from the effects of the mathematics anxiety cycle as illustrated in Figure 2:

Figure 2. The cycle perpetuated by first-generation elementary teachers with math anxiety

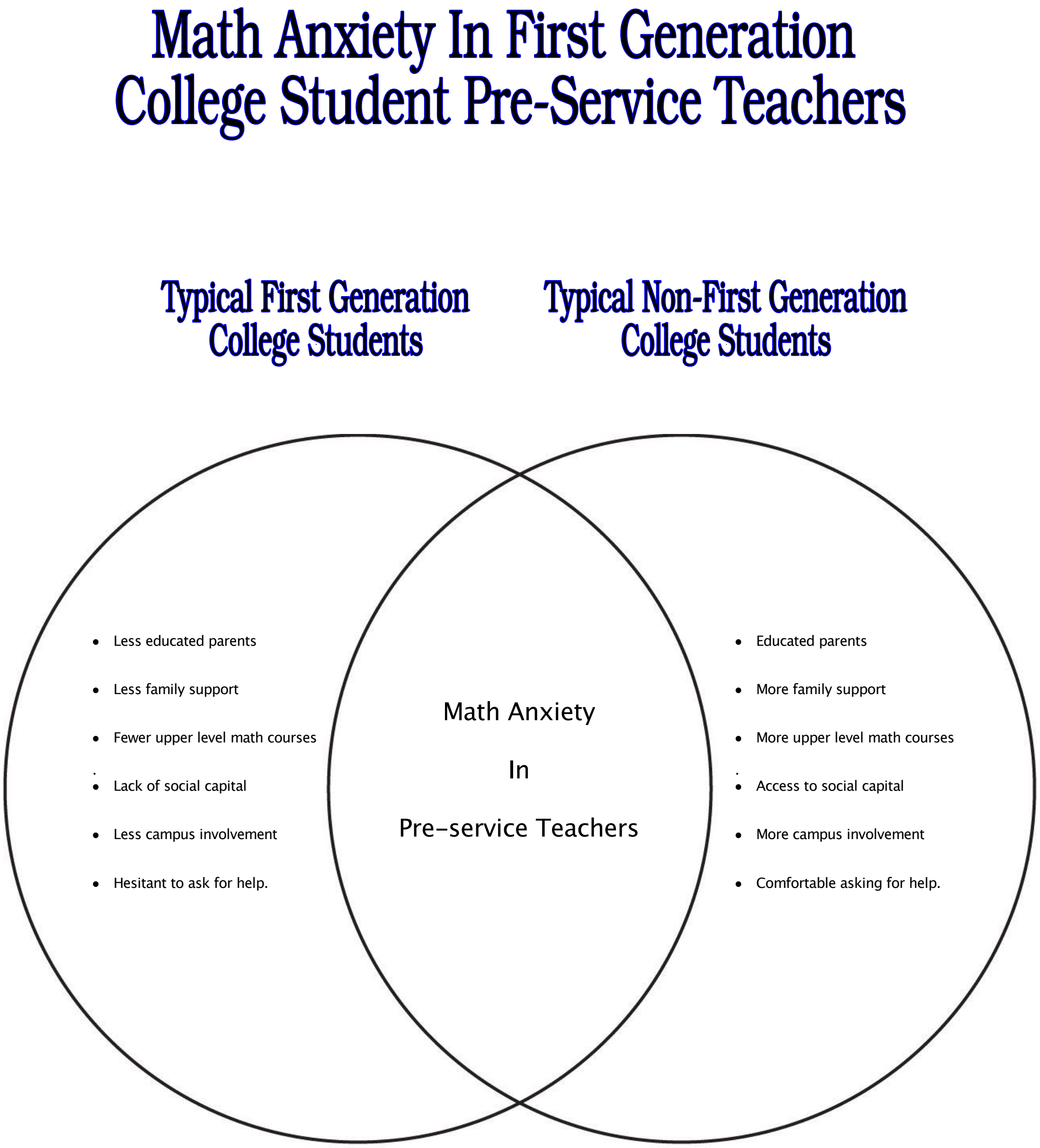


Studies have indicated that typical first-generation college students (in comparison to their non-first-generation peers) are likely to experience lower socio-economic status (Engle & Tinto, 2008; Gibbons et al., 2019; Lightweis, 2014), have lower GPAs (Chen, 2005; Hicks, 2003; Lee et al., 2004) and SAT scores (Atherton, 2014; Hicks, 2003), take fewer upper-level mathematics courses (Chen, 2005; Horn & Nunez, 2000), experience less support from their families (Chang et al., 2019; Gibbons et al., 2019; Hicks, 2003; Ishitani, 2006; McCarron & Inkelas, 2006; Moschetti & Hudley, 2015; Thayer, 2000), are less involved on their campuses (Engle & Tinto, 2008; Glaessgen et al., 2018; Pascarella et al., 2004), experience less access to social capital (Means & Pyne, 2017; Soria & Stebleton, 2013; Tate et al., 2015), and are more hesitant to ask for help when they need it (Glaessgen et al., 2018; Means & Pyne, 2017; Moschetti & Hudley, 2005).

While Figure 2 illustrates the perpetuating impact the facets of mathematics anxiety have on first-generation teachers and their students, the following figure narrows the focus to the parameters of this study by examining the differences between first-generation pre-service teachers and their non-first-generation peers. Figure 3 illustrates some of the resources typical non-first-generation students have access to, as well as the lack of resources accessible to first-generation students as they study to become teachers.

Taken together, I suggest first-generation college students who are studying to be teachers will experience mathematics anxiety to a greater degree than their non-first-generation peers. The resources available to typical college students in pre-service teaching programs may be unattainable for first-generation pre-service teachers which may lead to an increase in mathematics anxiety, therefore impacting their future students once they are in the field. The word "typical" is used in this figure to underscore the importance of not making assumptions about all first-generation college students or their peers. While some FGCS may have access to multiple resources and some non-FGCS may not, the word "typical" is used in this instance to denote the average population.

Figure 3. Math Anxiety in First-Generation College Student Pre-service Teachers



CHAPTER 3: METHODOLOGY

In this chapter, I will outline my design selection, data collection procedures, and analytical methods. I will conclude the chapter with ethical issues and possible limitations of my study. The following research questions were addressed in this study:

1. Do first-generation college students matriculated in Elementary Education programs at University of Maine System campuses suffer from mathematics anxiety to a greater degree than their non-first-generation peers?
2. Does the first-generation college student mathematics anxiety score effect vary based on perceived access to social capital?
3. Does the first-generation college student mathematics anxiety score effect vary based on level of parent education?

Design Selection

This exploratory study utilized quantitative research methods with a descriptive (factor-relating) design to examine the relationship between first generation pre-service teachers and their self-reported mathematics anxiety.

The independent (predictor) variable in this study is first-generation college status and the dependent (outcome) variable is the mathematics anxiety rating. My goal was to determine the relationship between variables in hopes of filling the gap in literature regarding first-generation college students who are enrolled as pre-service teachers and suffer from mathematics anxiety. Although I was primarily interested in the general relationship between first-generation pre-service teachers and their self-reported mathematics anxiety across the University of Maine system as a whole, I was also interested in determining whether campus affiliation impacts this relationship. If there are significant differences between campuses, it could be due to the specific student population, the curriculum, the culture, etc. and this is information that will likely inform and direct future research. In addition to these variables, I was also interested in determining whether gender, ethnicity, perceived access to social capital, parent education, or prior mathematics experiences impact FGCS's mathematics anxiety scores.

Population

The population I studied is pre-service teachers enrolled in undergraduate education programs at University of Maine system campuses: (approximate enrollment) - University of Maine at Augusta (61 students), University of Maine at Farmington (602 students), University of Maine at Fort Kent (2 students), University of Maine at Machias (77 students), University of Maine at Orono (328 students), University of Maine at Presque Isle (116 students), and University of Southern Maine (0 students). There is currently no undergraduate Education degree program at University of Southern Maine. Due to the low enrollment at the University of Maine at Fort Kent, I combined that campus's data with the University of Maine at Presque Isle campus's data. Currently, UM Fort Kent students who are majoring in Education transfer to UM Presque Isle after their second year to obtain their teaching degree from UM Presque Isle.

I collected and analyzed data from the entire population: all undergraduate students majoring in general K-12 education in University of Maine campuses across the state. Due to the nature of mathematics anxiety and how it impacts teachers of mathematics and their instructional practices, the following students were excluded from the study in order to narrow the focus on those who would be more likely to teach mathematics in their educational career:

- Education students who have chosen physical education, art, or music as their major
- Students who are studying Education as a minor, rather than a major

The UMS campuses are spread out over the entire state of Maine and encompass both rural and urban communities as well as varying socio-economic and ethnic groups. I believe this population provides generalizable data due to the variability between campuses. I do not expect to have to contend with any nuisance or confounding variables as I surveyed the entire population; my hope is that there was no bias in who responded to the survey. Surveying the entire population also helps to ensure both internal and external validity of the study.

Data Collection Procedures

I administered the 24-item MARS-R (Mathematics Anxiety Rating Scale -Revised) (Plake & Parker, 1982) to students enrolled in University of Maine campuses, using a Qualtrics survey. I chose to use a Qualtrics survey, rather than a paper/pencil survey, in hopes of encouraging students to participate using technology at a time most convenient for them. Although the gold standard for mathematics anxiety rating scales is the original 98-item MARS (Richardson & Suinn, 1972), the MARS-R is a reliable measure of test anxiety and is less cumbersome than the longer, original scale which makes it an attractive alternative. I predicted I would have a higher response rate if I could assure participants the survey wouldn't take much of their time. MARS-R measures mathematics anxiety on a 5-point Likert scale and yields a coefficient alpha reliability of .98 (Plake & Parker, 1982); I feel confident it is a suitable and reliable substitute for the MARS and yielded the information I hoped to gather.

Part I of the survey asked participants to provide demographic data: gender, age, ethnicity, UMS campus, parent education, and first-generation college student status.

Part II of the survey asked students a series of questions pertaining to access to assistance resources and campus involvement. I designed the questions in Part II based on work by Villalonga-Olives, Adams, & Kawachi (2016) that indicates social capital measurement questions should inquire about individuals' access to resources and participation in social groups outside of their normal social group (to include SES, race, ethnicity, etc.), as well as the level of trust they have in their neighbors, especially authority figures. Harpham, Grant, & Thomas (2002) incorporate questions around structural (connectedness) and cognitive (sharing/trust) resources in The Adapted Social Capital Assessment Tool (A-SCAT) and I designed my social capital questions using the tool as a guide.

Part III of the survey asked students questions about their prior experiences with math. These sections were provided at the beginning of the survey and prior to the rating scale to ensure all participant data is on one document.

Parts IV and V of the survey asked students to rate their level of anxiety after reading a series of 24 sentences that propose brief mathematics scenarios. The first 16 statements focus on learning mathematics anxiety while the remaining 8 statements focus on mathematics evaluation anxiety. Participants rated each statement on a 5-point Likert scale where 1 = no anxiety and 5 = significant anxiety. Mathematics anxiety rating scores can range from 24 (lowest) to 120 (highest).

Analytical Methods

An independent groups design T-test was employed to examine the relationship between MARS-R (mathematics anxiety) scores and first-generation pre-service teaching students as compared to non-first-generation pre-service teaching students. Data was exported to SPSS in order to manipulate and analyze the results. Student data was first analyzed as a whole before disaggregating students into groups based on first-generation status, major, campus affiliation, gender, parent education, perceived access to social capital, and prior experiences with mathematics.

Once the data was disaggregated, a series of multiple regressions was employed to determine if there is a relationship between first-generation pre-service teachers suffering from mathematics anxiety and major, campus size/affiliation, gender, parent education, perceived access to social capital, and prior experiences with mathematics. These analyses helped determine if there are any significant interactions between the additional co-variants. I performed t-tests and one-way Anova tests to determine if the null hypothesis could be rejected at an alpha level of .05.

Based on the literature review, I proposed that first-generation college Education students would score higher on the MARS-R scale than their non-first-generation college peers.

Null Hypothesis:

H_0: First-Gen College Education Students $\leq$ Non-First-Gen College Education Students

Alternative Hypothesis:

H_1: First-Gen College Education Students > Non-First-Gen College Education Students

I included exploratory analyses on the interactions of additional variables, to include campus affiliation, gender, perceived access to social capital, parent education, and prior mathematics experiences. This analytical method produced both descriptive and inferential statistics for this population and will lay the groundwork for potential future studies.

Ethical Issues

I am an Education professor at a university within the same system where I collected some of my data; I also teach mathematics methods courses to all elementary education students who attend the University of Maine at Presque Isle. I recognize there is the potential for bias due to my role as mathematics methods instructor at one of the affiliated universities and I was conscientious about being particularly objective when comparing data between universities. This concern should be mitigated using the quantitative study design.

I also have preconceived notions about pre-service teachers and mathematics anxiety due to my experiences as a professor in mathematics methods courses. Although I do not have data on my students' first-generation college status, I do have anecdotal data on some of the students based on conversations we've had in class regarding mathematics anxiety and socio-economic status. I kept any prior information gained in check as I explored the data I collected and did not arrive at any conclusions other than what the data suggested.

Because I will have some of the students I surveyed in my courses or as advisees, it's important to be respectful of their privacy (even though the surveys were anonymous) and not entertain conversations regarding the survey or participants' responses.

I am aware of all these biases/ethical issues and have avoided making personal judgments as I engaged in collecting and examining the data for this study.

CHAPTER 4: RESULTS

In this chapter I will describe the demographics of the sample as well as the reliability of the study. Then I will address the three research questions addressed in the study. I will also include additional tests performed with the collected data. This chapter will include both the statistical measures used to test the hypotheses and the results of the tests.

Sample

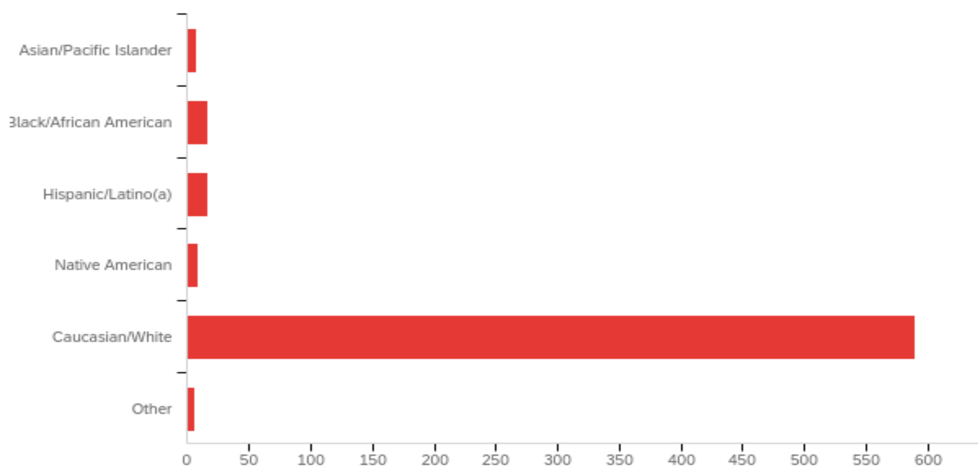
Demographics

1188 Qualtrics surveys were distributed to University of Maine System Education students via email on August 30, 2020. Reminder emails were sent on September 6 and September 13. 713 surveys were started and 636 responses were collected, with an 89% completion rate. Of the 636 collected responses, 554 completed the survey (and will make up my analytical sample), resulting in a 46.6% response rate. 496 answered all the questions on the survey, while 58 skipped the last section which focuses on mathematics testing anxiety. There was no need to de-identify participants when looking for relationships as there are no names attached to any surveys.

Respondents were asked to identify their current gender identity as male, female, or other (to include 1. Transgender female/trans woman or Male-to-Female (MTF) transgender, transsexual, or on the trans female spectrum, 2. Transgender male/trans man or Female-to-Male (FTM) transgender, transsexual, or on the trans male spectrum, 3. Non-binary, genderqueer, or genderfluid, 4. Gender identity not listed, and 4. Prefer not to reply). The vast majority of the respondents identified as female (82%), with 16% identifying as male and 1% identifying as other. Four respondents did not indicate gender identity.

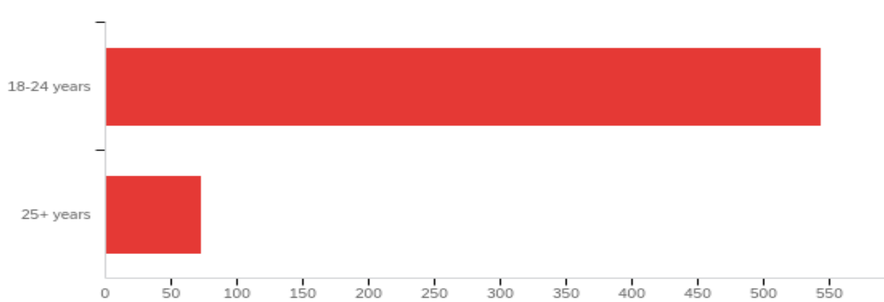
Respondents were asked to identify their ethnicity by choosing from six different ethnic categories (Asian/Pacific Islander, Black/African American, Hispanic/Latino(a), Native American, Caucasian/White, Other). 91.8% of the respondents identified as Caucasian/White, with only 4.2% reporting as non-white or multi-ethnic; approximately 4% did not report ethnicity. For that reason, I recoded ethnicity as white (0) versus non-white (1) with white being the referent group. Due to the absence of significant ethnic diversity in this sample, I did not perform any statistical tests to investigate differences in mathematics anxiety in regard to ethnicity.

Table 1. *Survey respondents' identified ethnicity*



Respondents were asked to identify their age: 88% reported being 18-24 years of age, with 12% reporting as 25 years or older.

Table 2. *Survey respondents' identified age*



Respondents were asked to indicate their first-generation college student status by indicating if either of their parents had completed a 4-year college degree. Upon first analysis, it appeared as though 44% of the respondents were first-generation college students (neither parent completed a 4-year college degree). After analyzing the next question that asked respondents what their parents' highest level of education was, it was clear some had answered the first-generation question incorrectly. For example, one particular student had chosen his/her status as non-first-generation but had also indicated neither of his/her parents had graduated from high school. Perhaps some students misread the question and thought they would only classify as a first-generation student if they were the first of their siblings to attend college. For this reason, I did not use the data from the first-generation survey question and instead gleaned that information from the question asking for parents' highest level of education. Using that data, 46% of students self-reported as being first-generation college students.

Table 3. *Survey respondents' identified first-generation status*

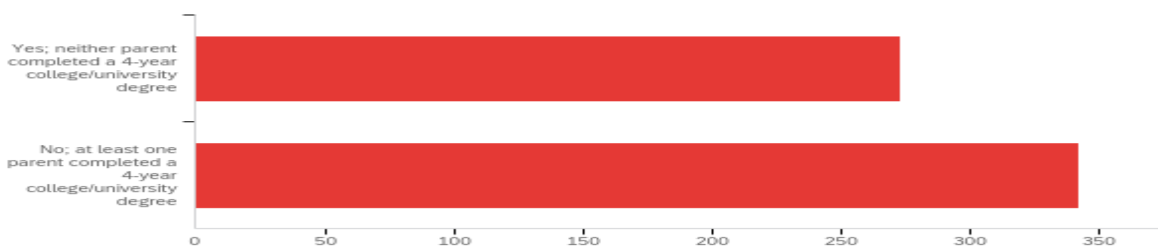
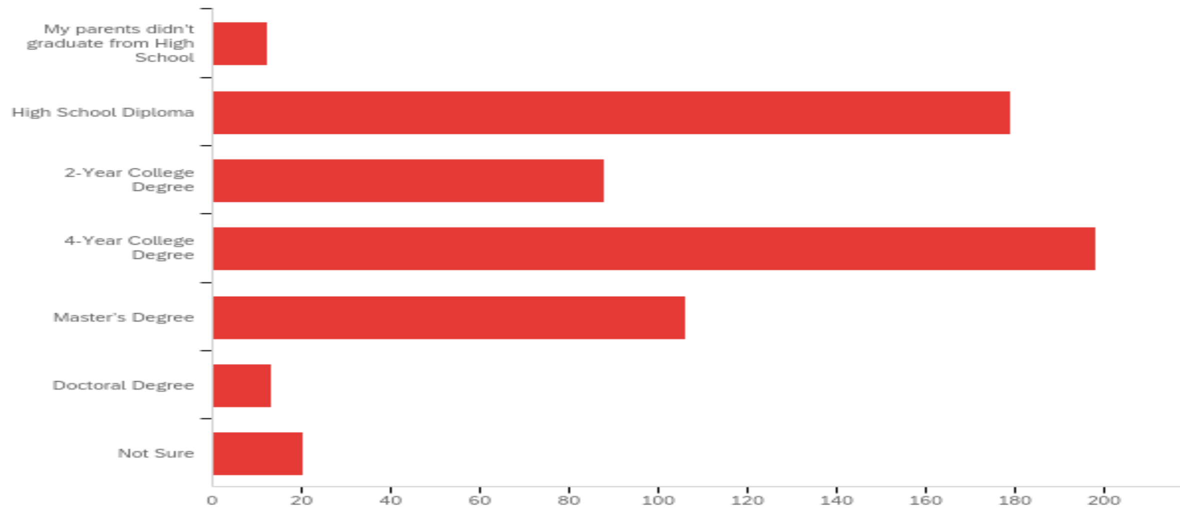
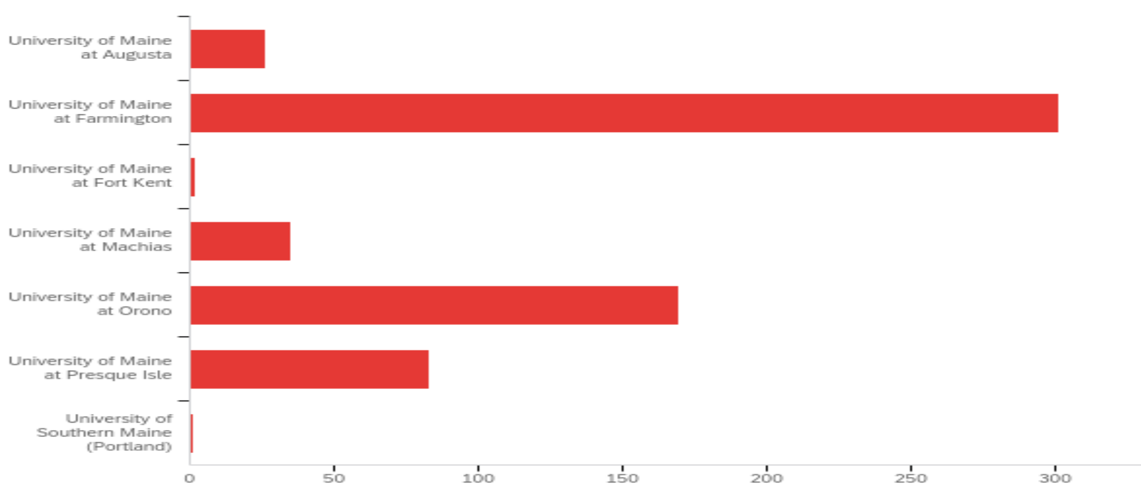


Table 4. *Survey respondents' identified parent education*



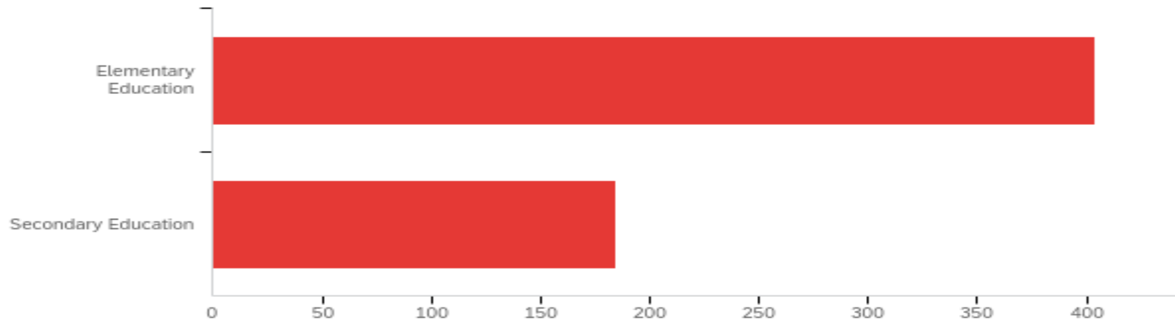
Regarding campus affiliation, 49% (n = 401) of the respondents attend the University of Maine at Farmington, 27% (n = 169) attend the University of Maine at Orono, 14% (n = 85) attend the University of Maine at Presque/Fort Kent, 6% (n = 35) attend the University of Maine at Machias, and 4% (n = 26) attend the University of Maine at Augusta. There is not currently an undergraduate degree program in Education at the University of Southern Maine (Portland).

Table 5. *Survey respondents' identified primary campus*



69% of those who responded to the survey were Elementary Education majors, while 31% were enrolled as Secondary Education majors.

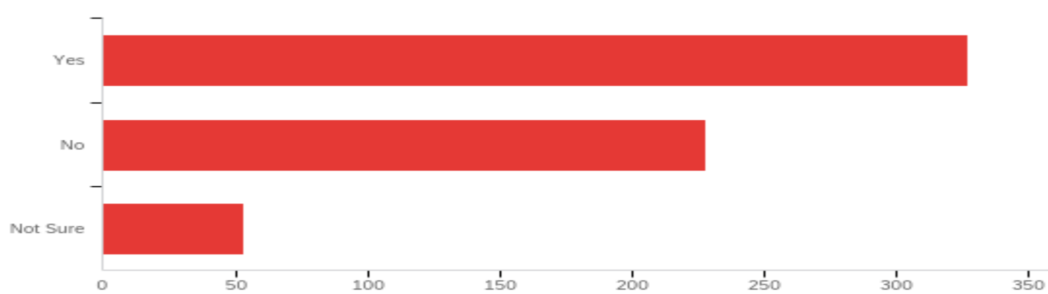
Table 6. *Survey respondents' identified major.*



Social Capital

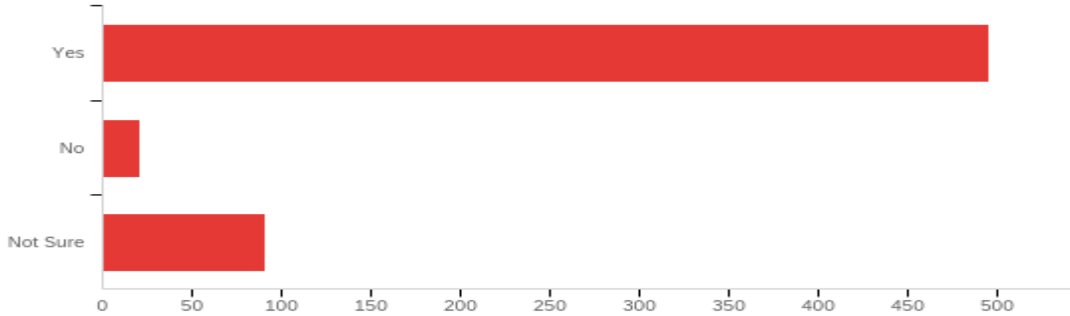
When asked if students had people at home who could help with schoolwork if they needed it, 54% responded yes, 37% responded no, and 9% indicated they weren't sure. I recoded the responses into Yes and No values by combining the No and Not Sure responses to result in 54% reporting having people at home who could help and 46% reporting not having that support at home.

Table 7. *Survey respondents' reported access to schoolwork help at home*



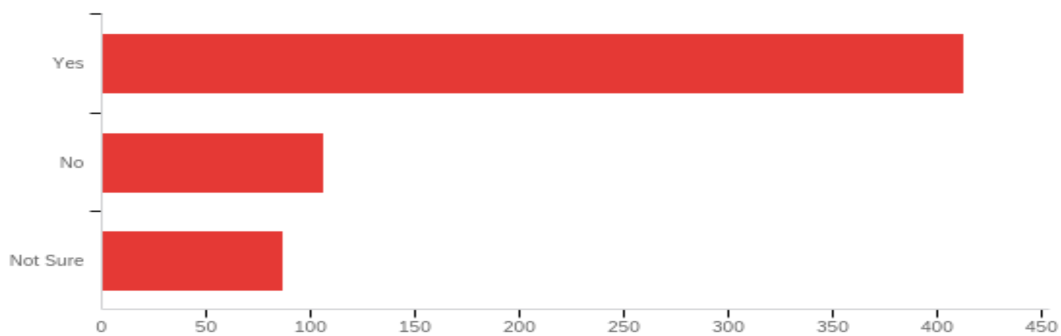
When asked if students had people at their university who could help with homework if they needed it, 82% responded yes, 3% responded no, and 15% indicated they weren't sure. I recoded the responses into Yes and No values by combining the No and Not Sure responses to result in 82% reporting they had people at their university who would help with homework and 18% reporting no such support.

Table 8. *Survey respondents' reported access to schoolwork help at their university*



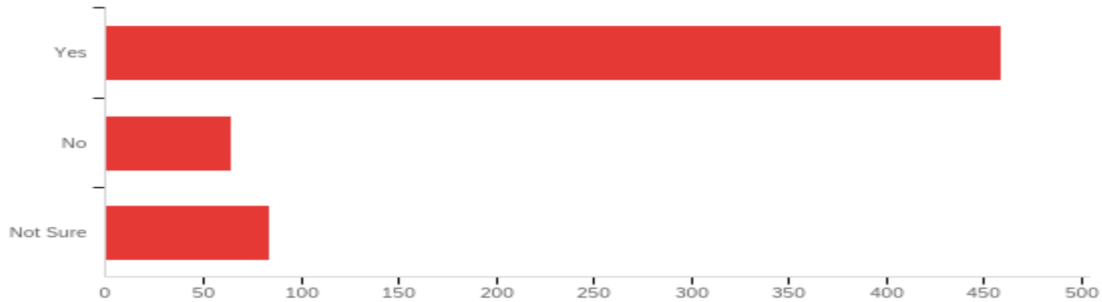
When asked if they knew how to access tutoring at their university, 68% of students responded yes, 17% responded no, and 15% indicated they weren't sure. I recoded the responses into Yes and No values by combining the No and Not Sure responses to result in 68% reporting they knew how to access tutoring at their university and 32% reporting difficulty in accessing tutoring.

Table 9. *Survey respondents' reported knowledge of how to access tutoring at school*



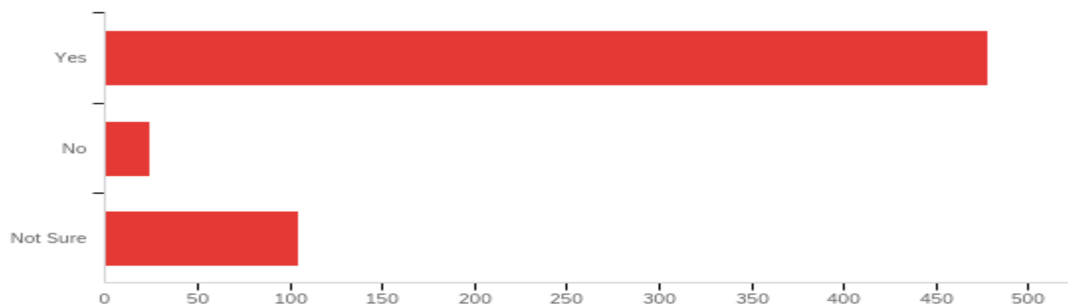
When asked if students felt comfortable asking professors for help with schoolwork, 76% responded yes, 10% responded no, and 14% indicated they weren't sure. I recoded the responses into Yes and No values by combining the No and Not Sure responses to result in 76% reporting they were comfortable asking their professors for help and 24% reporting they were not comfortable doing so.

Table 10. *Survey respondents' reported comfort in asking professors for help*



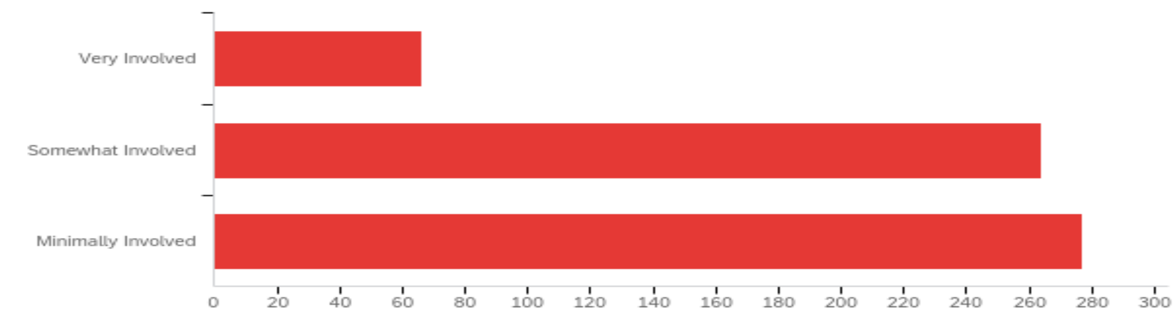
When asked if students felt they could trust people at their university to look out for their best interests, 78% responded yes, 4% responded no, and 18% indicated they weren't sure. I recoded the responses into Yes and No values by combining the No and Not Sure responses to result in 78% reporting they felt they could trust people at their university to look out for their best interests and 22% reporting no such trust.

Table 11. *Survey respondents' reported knowledge of trust in university faculty and staff*



When asked how students would rate their involvement in campus events and activities, 11% indicated they were very involved, 43% indicated they were somewhat involved, and 46% responded as minimally involved.

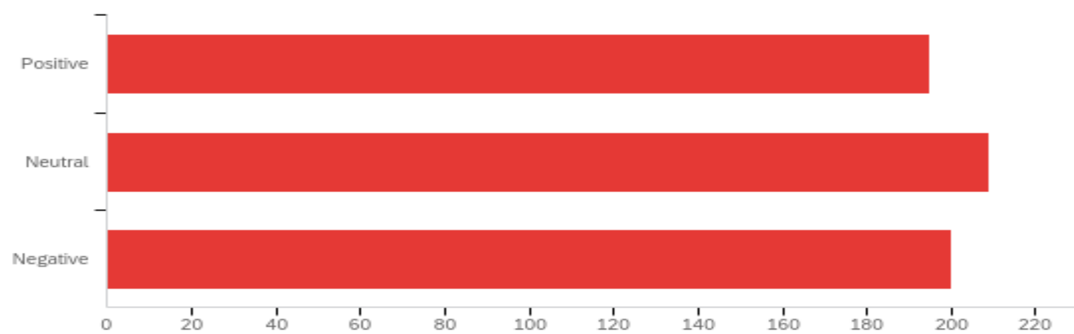
Table 12. *Survey respondents' reported campus involvement*



Prior Math Experiences

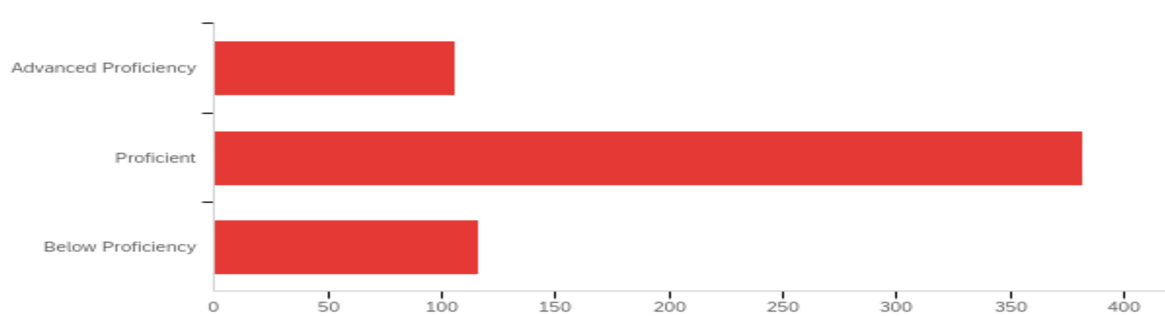
When asked to describe their experiences with mathematics, 33% reported their experiences as positive, 34% reported having neutral experiences, and 33% reported negative experiences.

Table 13. *Survey respondents' reported prior mathematic experiences*



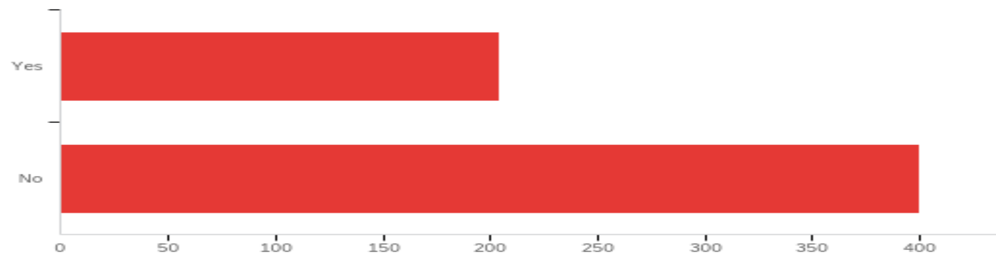
Regarding students' description of their mathematics proficiency, 18% self-reported advanced proficiency, 63% self-reported being proficient, and 19% self-reported being below proficient.

Table 14. *Survey respondents' reported prior mathematics proficiency*



35% of respondents reported taking advanced-level mathematics courses such as trigonometry or calculus, while 65% responded they had not taken advanced mathematics courses.

Table 15. *Survey respondents' reported participation in advanced-level mathematics courses*



Reliability

The remainder of the survey consists of the Math Anxiety Rating Scale – Revised (Plake & Parker, 1982) with 16 questions focused on mathematics learning anxiety and the remaining 8 questions focused on mathematics testing anxiety – 24 questions in total. This study resulted in very high reliability with a Cronbach's Alpha reliability rating of 0.964 for the first section (16 questions) of the mathematics anxiety rating scale (mathematics learning anxiety) with n=552, M=2.384, and SD=0.96. The Cronbach's Alpha reliability rating for the mathematics test anxiety section (8 questions) was 0.949 with n=511, M= 3.15, and SD=1.00

Research Question 1

Do first-generation college students matriculated in Education programs at University of Maine System campuses suffer from mathematics anxiety to a greater degree than their non-first-generation peers?

H_0: First-Gen $\leq$ Non-First-Gen, and H_1: First-Gen > Non-First-Gen.

No; an independent samples t-test indicated there is no significant difference between the *learning* mathematics anxiety scores (on the math anxiety rating scale – MARS-R) of first-generation college students (n=253) and their non-first-generation peers (n=281), $t(532) = .265$, $p = .791$ with a mean difference of .022.

Table 16. *Independent samples t-test comparing learning mathematics anxiety: first-gen and non-first-gen students*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
LearnAnx Math Learning Anxiety	Equal variances assumed	1.007	.316	.265	532	.791	.02188	.08258	-.14034	.18409
	Equal variances not assumed			.265	529.301	.791	.02188	.08243	-.14006	.18381

There is also no significant difference between the *testing* mathematics anxiety scores of first-generation college students (n=240) and their non-first-generation peers (n=255), $t(493) = .103$, $p = .918$ with a mean difference of .009.

Table 17. *Independent samples t-test comparing testing mathematics anxiety: first-gen and non-first-gen students*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TestAnx Math Test Anxiety	Equal variances assumed	1.074	.301	.103	493	.918	.00932	.09017	-.16785	.18649
	Equal variances not assumed			.104	493.000	.918	.00932	.09001	-.16752	.18616

These *p* values, which are much greater than alpha = .05, suggest the means for mathematics anxiety scores (both learning and testing) for all students are equal.

Student Major

While there was no overall effect for generational status, it's possible that there is a generational-status difference that varies based on student major (i.e., a generational status x major interaction). To determine that, I first examined whether there was a significant difference in anxiety based on a student's major. An independent samples t-test indicated there *is* a significant difference between the *learning* mathematics anxiety scores of Elementary (n=360) and Secondary Education (n=173) majors, not taking generational status into consideration. Elementary majors, in general, are much more mathematics anxious. $t(531) = 2.455$, $p = .014$, with roughly a ¼ of a Standard Deviation higher anxiety scores.

Table 18. *Independent samples t-test comparing learning mathematics anxiety by major*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
LearnAnx Math Learning Anxiety	Equal variances assumed	.041	.840	2.455	531	.014	.21809	.08882	.04361	.39258
	Equal variances not assumed			2.443	335.210	.015	.21809	.08926	.04251	.39368

A second independent samples t-test indicated there is no significant difference between the *testing* mathematics anxiety scores of Elementary (n=329) and Secondary Education (n=164) majors. Elementary and Secondary majors are equally mathematics anxious when it comes to testing. $t(491) = .899$, $p = .369$.

Table 19. *Independent samples t-test comparing testing mathematics anxiety by major*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TestAnx Math Test Anxiety	Equal variances assumed	1.749	.187	.899	491	.369	.08651	.09618	-.10247	.27550
	Equal variances not assumed			.884	311.254	.377	.08651	.09786	-.10604	.27907

Generational Status x Student Major Interaction

When looking at whether the difference in *learning* anxiety between first-gen students and their non-first-gen peers varied based on major, a regression indicated there was no significant interaction effect, $b = .033$, $t(512) = .183$, $p = .855$.

Table 20. *Regression comparing learning mathematics anxiety by major and generational status*

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	Upper Bound	Correlations Zero-order	Partial	Part
1	(Constant)	2.413	.066		36.447	.000	2.283	2.543			
	Gen1 FirstGen	-.027	.084	-.014	-.319	.750	-.192	.139	-.009	-.014	-.014
	Major Major	-.208	.089	-.102	-2.321	.021	-.383	-.032	-.101	-.102	-.102
2	(Constant)	2.418	.072		33.396	.000	2.276	2.560			
	Gen1 FirstGen	-.038	.103	-.020	-.366	.715	-.239	.164	-.009	-.016	-.016
	Major Major	-.223	.122	-.110	-1.823	.069	-.463	.017	-.101	-.080	-.080
	majorxgen1	.033	.180	.012	.183	.855	-.320	.386	-.061	.008	.008

a. Dependent Variable: LearnAnx Math Learning Anxiety

There is similarly no significant interaction between generational status and major when predicting *testing* anxiety, b = -.086, t(474) = -.437, p = .662.

Table 21. *Regression comparing testing mathematics anxiety by major and generational status*

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	Upper Bound	Correlations Zero-order	Partial	Part
1	(Constant)	3.170	.074		42.602	.000	3.024	3.316			
	Gen1 FirstGen	-.008	.092	-.004	-.085	.932	-.190	.174	.000	-.004	-.004
	Major Major	-.082	.098	-.038	-.834	.405	-.274	.111	-.038	-.038	-.038
2	(Constant)	3.155	.082		38.498	.000	2.994	3.316			
	Gen1 FirstGen	.021	.113	.010	.182	.855	-.202	.243	.000	.008	.008
	Major Major	-.042	.133	-.020	-.316	.752	-.304	.220	-.038	-.014	-.014
	majorxgen1	-.086	.196	-.030	-.437	.662	-.472	.300	-.037	-.020	-.020

a. Dependent Variable: TestAnx Math Test Anxiety

Generational Status x Type of Anxiety Interaction

A paired-samples *t*-test indicated there is a significant difference between all students' *learning* anxiety (n = 510, M = 2.34) and their *testing* anxiety (n = 510, M = 3.15), $t(509) = -33.81$, $p < .001$.

Table 22. *Paired samples t-test comparing students' learning/testing mathematics anxiety*

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	LearnAnx Math Learning Anxiety - TestAnx Math Test Anxiety	-.80592	.53827	.02383	-.85274	-.75909	-33.813	509	.000

In general, students are more test anxious than they are learning anxious when it comes to mathematics. A repeated measure ANOVA (within subjects) determined the learning/test difference did not vary by generational status; there was no interaction between type of anxiety and generational status, $F(1,492) = .205$, $p = .651$.

Table 23. *Repeated measure ANOVA comparing students' learning/testing mathematics anxiety and generational status*

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
AnxTyp	Sphericity Assumed	162.560	1	162.560	1112.661	.000
	Greenhouse-Geisser	162.560	1.000	162.560	1112.661	.000
	Huynh-Feldt	162.560	1.000	162.560	1112.661	.000
	Lower-bound	162.560	1.000	162.560	1112.661	.000
AnxTyp * Gen1	Sphericity Assumed	.030	1	.030	.205	.651
	Greenhouse-Geisser	.030	1.000	.030	.205	.651
	Huynh-Feldt	.030	1.000	.030	.205	.651
	Lower-bound	.030	1.000	.030	.205	.651
Error(AnxTyp)	Sphericity Assumed	71.881	492	.146		
	Greenhouse-Geisser	71.881	492.000	.146		
	Huynh-Feldt	71.881	492.000	.146		
	Lower-bound	71.881	492.000	.146		

Research Question 2

Does the first-generation college student mathematics anxiety score effect vary based on perceived access to social capital?

H_0: First-Gen $\leq$ Non-First-Gen, and H_1: First-Gen > Non-First-Gen.

Generational Status Predicting Social Capital

There is no significant difference between perceived access to social capital for first-generation students (n=253, M=1.45) and their non-first-gen peers (n=282, M=1.35) with lower scores indicating more social capital: $t(533) = -.882$, $p = .378$. These findings suggest students whose parents have not received a 4-year degree are not limited to social capital access.

Table 24. *Independent samples t-test comparing students' access to social capital and generational status*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SocCap	Equal variances assumed	5.362	.021	-.882	533	.378	-.09558	.10837	-.30846	.11731
	Equal variances not assumed			-.886	532.858	.376	-.09558	.10783	-.30740	.11625

Perceived access to social capital is high for both first-generation and non-first-generation students.

Social Capital Predicting Mathematics Anxiety

When testing to determine if social capital is related to mathematics anxiety, the correlations indicated significance for both learning mathematics anxiety (r(n=550)=.252, $p <$ .001) and testing mathematics anxiety (r(n=509)=.202, $p < .001$).

Table 25. *Correlation for learning/testing mathematics anxiety and social capital*

Correlations

		LearnAnx Math Learning Anxiety	TestAnx Math Test Anxiety	SocCap
LearnAnx Math Learning Anxiety	Pearson Correlation	1	.851	.252
	Sig. (2-tailed)		.000	.000
	N	552	510	550
TestAnx Math Test Anxiety	Pearson Correlation	.851	1	.202
	Sig. (2-tailed)	.000		.000
	N	510	511	509
SocCap	Pearson Correlation	.252	.202	1
	Sig. (2-tailed)	.000	.000	
	N	550	509	552

There is a moderate effect for all University of Maine System students' access to social capital and learning mathematics anxiety. Students who report less access to social capital have higher mathematics anxiety.

Social Capital x Generational Status Interaction

Regression analyses to determine if the perceived access to social capital effect varied by generation for both learning anxiety (b = -.001, t(529) = -.173, p =.863) and test anxiety (b = -.046, t(490) = .644, p = .520) indicated no significant effect. These findings indicate that the effect of social capital is equivalent for all UMS students, regardless of generational status.

Table 26. *Regression comparing learning mathematics anxiety by generational status*

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations		
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	2.105	.070		29.930	.000	1.967	2.243			
	Gen1 FirstGen	-.042	.081	-.022	-.525	.600	-.200	.116	-.014	-.023	-.022
	SocCap	.178	.032	.233	5.510	.000	.114	.241	.232	.233	.233
2	(Constant)	2.098	.080		26.344	.000	1.942	2.255			
	Gen1 FirstGen	-.027	.122	-.014	-.218	.828	-.266	.213	-.014	-.009	-.009
	SocCap	.183	.043	.239	4.291	.000	.099	.266	.232	.183	.181
	Gen1xSocCap	-.011	.065	-.013	-.173	.863	-.140	.117	.100	-.008	-.007

a. Dependent Variable: LearnAnx Math Learning Anxiety

Table 27. *Regression comparing testing mathematics anxiety by generational status*

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part
1	(Constant)	2.932	.079		37.141	.000	2.777	3.087			
	Gen1 FirstGen	-.017	.089	-.009	-.197	.844	-.192	.157	-.007	-.009	-.009
	SocCap	.156	.036	.194	4.392	.000	.086	.226	.194	.194	.194
2	(Constant)	2.959	.089		33.132	.000	2.783	3.134			
	Gen1 FirstGen	-.083	.135	-.041	-.615	.539	-.347	.182	-.007	-.028	-.027
	SocCap	.137	.047	.170	2.938	.003	.045	.228	.194	.132	.130
	Gen1xSocCap	.046	.072	.050	.644	.520	-.095	.188	.106	.029	.029

a. Dependent Variable: TestAnx Math Test Anxiety

Follow-up Analysis: Social Capital at Home

An independent samples t-test determined students who report not having anyone at home who can help with mathematics do *not* have higher *learning* mathematics anxiety than those who report having someone at home who can help with mathematics, $t(550) = -.742$, $p = .458$, and a regression determined the effect does not vary by generational status, $t(530) = .429$, $p = .668$.

Table 28. *Independent samples t-test comparing learning mathematics anxiety and home help*

Independent Samples Test

		Levene's Test for Equality of Variances F	Levene's Test for Equality of Variances Sig.	t-test for Equality of Means t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
LearnAnx Math Learning Anxiety	Equal variances assumed	1.829	.177	-.742	550	.458	-.06092	.08206	-.22210	.10026
	Equal variances not assumed			-.739	522.035	.460	-.06092	.08247	-.22293	.10108

Table 29. *Regression comparing learning mathematics anxiety and home help by generational status*

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part
1	(Constant)	2.326	.063		37.023	.000	2.202	2.449			
	Gen1 FirstGen	-.040	.087	-.021	-.464	.643	-.211	.130	-.011	-.020	-.020
	HomeHelpSC	.059	.087	.031	.681	.496	-.112	.231	.024	.030	.030
2	(Constant)	2.337	.068		34.211	.000	2.203	2.471			
	Gen1 FirstGen	-.075	.119	-.039	-.631	.528	-.308	.158	-.011	-.027	-.027
	HomeHelpSC	.022	.123	.011	.178	.859	-.221	.265	.024	.008	.008
	Gen1xHomeHelpSC	.075	.175	.036	.429	.668	-.268	.418	.017	.019	.019

a. Dependent Variable: LearnAnx Math Learning Anxiety

Similarly, the *testing* anxiety score was not significantly different for those students who reported having someone at home who could help with mathematics compared to those students who reported not having someone at home who could help with mathematics, $t(509) = -.147$, $p = .883$. Additionally, a regression indicated the effect does not vary by generational status, $t(491) = .307$, $p = .759$.

Table 30. *Independent samples t-test comparing testing mathematics anxiety and home help*

Independent Samples Test

		Levene's Test for Equality of Variances F	Levene's Test for Equality of Variances Sig.	t-test for Equality of Means t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
TestAnx Math Test Anxiety	Equal variances assumed	.370	.543	-.147	509	.883	-.01307	.08904	-.18799	.16185
	Equal variances not assumed			-.147	499.689	.883	-.01307	.08912	-.18815	.16202

Table 31. *Regression comparing testing mathematics anxiety and home help by generational status*

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part
1	(Constant)	3.145	.070		44.857	.000	3.008	3.283			
	Gen1 FirstGen	-.012	.094	-.006	-.128	.898	-.197	.173	-.005	-.006	-.006
	HomeHelpSC	.010	.094	.005	.101	.919	-.176	.195	.003	.005	.005
2	(Constant)	3.155	.077		41.069	.000	3.004	3.306			
	Gen1 FirstGen	-.039	.130	-.020	-.304	.761	-.295	.216	-.005	-.014	-.014
	HomeHelpSC	-.020	.134	-.010	-.146	.884	-.283	.243	.003	-.007	-.007
	Gen1xHomeHelpSC	.058	.189	.027	.307	.759	-.313	.429	.006	.014	.014

a. Dependent Variable: TestAnx Math Test Anxiety

Follow-up Analysis: Social Capital at the University

Although the majority of UMS students surveyed reported having access to social capital, an independent samples t-test determined students who reported not having anyone at their university who can help with mathematics (n=103) report higher *learning* mathematics anxiety (M=2.594) than their peers (n=448) with a mean score of 2.295, $t(549) = -2.874$, $p = .004$.

Table 32. *Independent samples t-test comparing learning mathematics anxiety and university help*

Independent Samples Test

		Levene's Test for Equality of Variances F	Levene's Test for Equality of Variances Sig.	t-test for Equality of Means t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
LearnAnx Math Learning Anxiety	Equal variances assumed	.298	.586	-2.874	549	.004	-.29929	.10413	-.50384	-.09475
	Equal variances not assumed			-2.901	154.053	.004	-.29929	.10317	-.50311	-.09547

These students (n=99) also reported having higher *testing* anxiety (M=3.354) than their peers (n=411) with a mean score of 3.105: $t(508) = -2.225$, $p = .027$. These results are statistically significant and indicate student access to help at university is associated with lower anxiety.

Table 33. *Independent samples t-test comparing testing mathematics anxiety and university help*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TestAnx Math Test Anxiety	Equal variances assumed	.347	.556	-2.225	508	.027	-.24883	.11185	-.46857	-.02908
	Equal variances not assumed			-2.254	151.215	.026	-.24883	.11037	-.46690	-.03075

Research Question 3

Does the first-generation college student mathematics anxiety score effect vary based on level of parent education?

H_0: First-Gen $\leq$ Non-First-Gen, and H_1: First-Gen > Non-First-Gen.

No; there is no significant difference in mathematics anxiety scores for students based on their parents' level of education. While previous analyses separated students into two groups (non-first-generation (4-year degree or more) and first-generation (less than 4-year degree)), these analyses looked at parent education as a 3-level variable to include 1) less than 2-year degree, 2) 2-year degree, and 3) 4-year degree or more. An ANOVA test indicated students whose parents did not graduate with at least a 2-year degree were no more anxious *learning* mathematics than their peers whose parents had at least a 2-year college degree: $F(2,531) = .115$, $p = .892$.

Table 34. *ANOVA test comparing learning mathematics anxiety and parent education*

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.209	2	.104	.115	.892[b]
	Residual	482.820	531	.909		
	Total	483.028	533			

a. Dependent Variable: LearnAnx Math Learning Anxiety

b. Predictors: (Constant), ComColl ComColl, Gen1 FirstGen

The same was true of students' *testing* mathematics anxiety: $F(2,492) = .010$, $p = .990$.

Table 35. *ANOVA test comparing testing mathematics anxiety and parent education*

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.019	2	.010	.010	.990[b]
	Residual	495.587	492	1.007		
	Total	495.606	494			

a. Dependent Variable: TestAnx Math Test Anxiety

b. Predictors: (Constant), ComColl ComColl, Gen1 FirstGen

These *p* values, which are much greater than alpha = .05, suggest students' mathematics anxiety is not significantly impacted by their parents' level of education.

Exploratory Analyses

Finally, while not part of the formal hypotheses, a series of exploratory analyses examined the relationship between various student characteristics and math anxiety scores. Although the campus students attend did not statistically impact their mathematics anxiety scores, their gender, age, and mathematics experiences were all significant factors in their mathematics anxiety.

Math Anxiety and Gender

To determine whether students' gender impacted their mathematics anxiety scores, I performed an independent samples t-test. This test indicated there is a statistically significant difference between the *learning* mathematics anxiety scores of male (n=85, M=1.958) and female (n=455, M=2.417) students enrolled as Education majors across the University of Maine System, $t(538) = -4.127$, $p < .001$.

Table 36. *Independent samples t-test comparing learning mathematics anxiety and gender*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
LearnAnx Math Learning Anxiety	Equal variances assumed	3.338	.068	-4.127	538	.000	-.45984	.11143	-.67873	-.24095
	Equal variances not assumed			-4.348	123.441	.000	-.45984	.10576	-.66918	-.25050

There was also a statistically significant difference between the *testing* mathematics anxiety scores of male (n=80, M=2.650) and female (n=419, M=3.238) Education majors, $t(497) = -4.936$, $p < .001$. It should be noted that the *testing* anxiety scores were higher for both groups of students.

Table 37. *Independent samples t-test comparing testing mathematics anxiety and gender*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TestAnx Math Test Anxiety	Equal variances assumed	.654	.419	-4.936	497	.000	-.58839	.11920	-.82259	-.35418
	Equal variances not assumed			-4.705	106.812	.000	-.58839	.12507	-.83632	-.34045

Math Anxiety and Age

To determine whether students' age impacted their mathematics anxiety scores, I performed an independent samples t-test. This test indicated there was not a statistically significant difference between the *learning* mathematics anxiety scores of students between the ages of 18-24 (n=486, M=2.354) and their peers ages 25+ (n=66, M=2.302), $t(550) = .411$, $p = .681$.

Table 38. *Independent samples t-test comparing learning mathematics anxiety and age*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
LearnAnx Math Learning Anxiety	Equal variances assumed	.128	.720	.411	550	.681	.05183	.12602	-.19571	.29937
	Equal variances not assumed			.403	82.596	.688	.05183	.12870	-.20417	.30783

There was a significant difference between the *testing* anxiety scores of students between the ages of 18-24 (n=450, M=3.191) and their peers ages 25+ (n=61, M=2.855), $t(509) = 2.467$, $p = .014$. It should be noted that students 25 years and older experience less *testing* anxiety than their younger peers with a mean difference of .336.

Table 39. *Independent samples t-test comparing testing mathematics anxiety and age*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TestAnx Math Test Anxiety	Equal variances assumed	.135	.714	2.467	509	.014	.33613	.13624	.06846	.60379
	Equal variances not assumed			2.524	78.302	.014	.33613	.13315	.07106	.60120

Mathematics Anxiety and Upper-level Mathematics Courses

To determine whether students' participation in upper-level mathematics courses, such as trigonometry and calculus, impacted their mathematics anxiety scores, I performed an independent samples t-test. This test indicated there is a statistically significant difference between the *learning* mathematics anxiety scores of students who have taken upper-level mathematics courses (n=193, M=1.904) and their peers who have not taken upper-level mathematics courses (n=358, M=2.588), $t(549) = -8.467$, $p < .001$. There was also a statistically significant difference between the *testing* mathematics anxiety scores of students who have taken upper-level mathematics courses (n=182, M=2.709) and their peers who have not taken upper-level mathematics courses (n=328, M=3.390), $t(508) = -7.789$, $p < .001$. Students who have taken upper-level mathematics courses are significantly less anxious than their peers. Again, the *testing* anxiety scores are higher for both groups.

Table 40. *Independent samples t-test comparing learning/testing mathematics anxiety and upper-level mathematics courses*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
LearnAnx Math Learning Anxiety	Equal variances assumed	3.867	.050	-8.467	549	.000	-.68384	.08076	-.84249	-.52520
	Equal variances not assumed			-8.740	430.367	.000	-.68384	.07824	-.83763	-.53005
TestAnx Math Test Anxiety	Equal variances assumed	1.745	.187	-7.789	508	.000	-.68385	.08779	-.85633	-.51136
	Equal variances not assumed			-7.660	355.817	.000	-.68385	.08928	-.85943	-.50827

Mathematics Anxiety and Mathematics Performance

To determine whether students' self-reported history of mathematics performance impacted their mathematics anxiety scores, I performed a one-way ANOVA test. This test indicated there is a statistically significant difference between the *learning* mathematics anxiety scores of students who self-report as performing at an advanced level in mathematics (n=99, M=1.434), a proficient level in mathematics (n=339, M=2.312), and below proficiency in mathematics (n=103, M=3.353, $F(2,548) = 159.955$, $p < .001$. There was also a statistically significant difference between the *testing* mathematics anxiety scores of students who self-report as performing at an advanced level in mathematics (n=95, M=2.221), a proficient level in mathematics (n=322, M=3.165), and below proficiency (n=93, M=4.044, $F(2,507) = 111.098$, $p < .001$. Students who self-report as demonstrating advanced proficiency score lower on the mathematics anxiety rating scale than their peers who self-report as proficient or below proficiency in mathematics. Once again, all students score higher on *testing* anxiety than they do on *learning* anxiety.

Table 41. *ANOVA test comparing learning/testing mathematics anxiety and performance*

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
LearnAnx Math Learning Anxiety * MathPerf MathPerf	Between Groups	(Combined)	187.132	2	93.566	159.955	.000
	Within Groups		320.555	548	.585		
	Total		507.688	550			
TestAnx Math Test Anxiety * MathPerf MathPerf	Between Groups	(Combined)	156.339	2	78.169	111.098	.000
	Within Groups		356.729	507	.704		
	Total		513.068	509			

Mathematics Anxiety and Mathematics Experiences

To determine whether students' personal feelings regarding mathematics (positive, neutral, negative) impacted their mathematics anxiety scores, I performed an ANOVA. This test indicated there is a statistically significant difference between the *learning* mathematics anxiety scores of students who indicate they have positive feelings regarding mathematics (n=180, M=1.543), neutral feelings regarding mathematics (n=186, M=2.309), and negative feelings regarding mathematics (n=185, M=3.173, $F(2,548) = 251.781$, $p < .001$). There is also a statistically significant difference between the *testing* mathematics anxiety scores of students who indicate they have positive feelings regarding mathematics (n=173, M=2.343), neutral feelings regarding mathematics (n=170, M=3.227), and negative feelings regarding mathematics (n=167, M=3.149, $F(2,507) = 173.929$, $p < .001$). Students who report having positive feelings regarding mathematics score lower on the mathematics anxiety rating scale (both learning and testing anxiety) than their peers who report having neutral or negative feelings regarding mathematics.

Table 42. *One-way ANOVA test comparing learning/testing mathematics anxiety and mathematics experiences*

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
LearnAnx Math Learning Anxiety * MathExp MathExp	Between Groups	(Combined)	243.117	2	121.558	251.781	.000
	Within Groups		264.571	548	.483		
	Total		507.688	550			
TestAnx Math Test Anxiety * MathExp MathExp	Between Groups	(Combined)	208.777	2	104.388	173.929	.000
	Within Groups		304.291	507	.600		
	Total		513.068	509			

CHAPTER 5: DISCUSSION

In this chapter I will summarize my findings and draw relevant conclusions. I will organize my discussion by answering each of the research questions, followed by a summary and discussion on my exploratory analyses. I have reordered the research questions in order to focus more on the second question; I believe the data on perceived access to social capital is significant and warrants further discussion and research.

Research Question 1

Do first-generation college students matriculated in Education programs at University of Maine System campuses suffer from mathematics anxiety to a greater degree than their non-first-generation peers?

There was no statistically significant difference between the *learning* and *testing* anxiety scores of first-generation students and their peers. The majority of students indicated higher *testing* anxiety than *learning* anxiety, and generational status was not a factor. Although first-generation pre-service teachers did not report higher mathematics anxiety scores than their non-first-generation peers (and I was not able to reject the null hypothesis), I believe my findings are significant. Research indicates that first-generation college students are more likely to struggle with mathematics (Atherton, 2014; Chen, 2005; Hicks, 2003; Lee et al., 2004) and that students who struggle with mathematics and have lower mathematics self-efficacy are more likely to suffer from mathematics anxiety (Griggs et al., 2013; Huang et al., 2019); these findings suggest that first-generation pre-service teachers would likely suffer from mathematics anxiety to a greater degree than their non-first-generation peers. Although my data do indicate students who struggle with mathematics have greater mathematics anxiety, generational status is not a factor.

Here are some generative questions that emerge from my findings: Do all pre-service teachers struggle with mathematics anxiety to a greater degree than their peers who are not studying to be teachers? This would line up with research that indicates students studying to be elementary teachers have higher mathematics anxiety than any other major (Gonzales-DeHass et al., 2017; Van der Sandt & Obrien, 2017). Do first-generation pre-service teachers have access to enough resources and support on UMS campuses that they are less anxious about mathematics, or in general?

Also of interest is the finding that all students, regardless of generational status or degree of mathematics anxiety, experience more mathematics *testing* anxiety than mathematics *learning* anxiety. Is this a result of school accountability and high stakes testing that has become commonplace in our public schools? A study of 11th graders that looked at test anxiety and large-scale testing suggests test anxiety is a significant predictor of test performance (von der Embse, N. P. & Witmer, S. E. (2014). Is the accountability pressure on public schools trickling down to students in ways that increase their test anxiety across the board? At any rate, it's clear that learning mathematics isn't as anxiety producing as being tested in mathematics for this population. Perhaps even learning mathematics would be less anxiety producing if students weren't focused on the eventual testing process. These findings indicate the need for further research and possible interventions or changes in practice.

Another finding indicates almost half (46%) of the pre-service teachers who participated in the study identified as first-generation college students. A study several years ago indicated that although first-generation college students have typically gravitated toward 2-year colleges, many are now enrolling in 4-year universities (Gallavan & Benson, 2014). According to The Postsecondary National Policy Institute (2021) factsheet, only 39% of first-generation college students attend four-year universities while 53% attend two-year colleges. Perhaps UMS campuses have a larger than typical FGCS population, or perhaps a large portion of these students is enrolling in teacher education programs.

These findings could be problematic in that the mathematics anxiety cycle will continue to be perpetuated through mathematics anxious teachers (first-generation or not) who pass the anxiety on to their students (Bekdemir, 2010; Whyte & Anthony, 2012). The Postsecondary National Policy Institute (2021) factsheet indicated that first-generation students demonstrate less college-readiness than their peers and that 36% are required to take remedial courses in the first two years of college. If generational status does not impact pre-service teachers' mathematics anxiety, perhaps all pre-service teachers are even more anxious than we think. If non-first-generation college students who are studying to be teachers are just as anxious their first-generation peers, even though they have likely had more success, support, and access to resources throughout their education, perhaps additional support should be provided to all our pre-service teachers (such as the support available to first-generation college students) to help break this cycle.

Conversely, is there no statistically significant difference in mathematics anxiety between the two groups because first-generation college students are well-supported (to the same degree as their peers) and have access to the resources they need to be successful? This will be discussed further in the RQ 2 discussion. Again, additional studies are necessary to answer these questions.

Research Question 3

Does the first-generation college student mathematics anxiety score effect vary based on level of parent education?

While RQ 1 separated students by non-first-generation status (at least one parent achieved a 4-year degree) and first-generation status (neither parent achieved a 4-year degree), this question separated students by whether or not one of their parents had at least 2 years of college as compared to students whose parents did not achieve a 2-year degree – including those students whose parents who did not graduate from high school. Based on existing literature, it would make sense for students whose parents had less education to be more mathematics anxious. Data indicated students whose parents did not graduate with at least a 2-year degree were no more anxious learning or testing in mathematics than their peers whose parents had at least a 2-year college degree. These findings indicate level of parent education (whether it includes a four-year degree or not) does not impact math anxiety.

These findings are important and contrast with existing research on first-generation students that indicates parent education is significant regarding students' success and self-concepts (Covarrubias, R., Jones, J., & Johnson, R., 2018). Beilock and Willingham (2014) also found that 80% of community college students suffer from mathematics anxiety, which supports the idea that first-generation college students may, in fact, suffer from mathematics anxiety to a greater degree than their non-first-generation peers. Parents' mathematics anxiety and attitudes can transfer to their children, causing increased mathematics anxiety that can negatively influence math achievement and performance in their children (Soni & Kumari, 2015), so I was surprised and pleased to find that parent level of education did not significantly impact pre-service teachers' mathematics anxiety. This is good news; conceivably, we are making progress with our first-generation college students and their post-secondary success regarding mathematics.

These findings suggest the level of parent education isn't significant, at least in regard to mathematics anxiety. This may be due, in part, to the increased resources and support systems most universities offer first-generation college students. First-year students are often required to take a first-year seminar course to help ease into college life. These courses alert students to the various resources available on their campuses, such as tutoring, student study groups and centers, financial aid, etc. These resources could be partially responsible for the success many students (regardless of generational status) experience and should be available to all post-secondary students to increase their college success. Almeida et al. (2019) found that access to social capital via college faculty and staff positively impacts first-generation college students' grade point average so it would make sense that their mathematics anxiety would also be mitigated to some degree by that access. These findings indicate continued and improved efforts to support students are necessary. More discussion on this will follow in the remaining research questions and Implications section.

Research Question 2

Does the first-generation college student mathematics anxiety score effect vary based on perceived access to social capital?

Data did not indicate first-generation students' perceived access to social capital was less than their non-first-generation peers' perceived access; this is in contrast to the findings of Moschetti & Hudley (2005), Mean & Pyne (2017), Chang et al. (2019), and Almeida et al. (2019). Data also indicated that the effect of social capital is equivalent for all UMS students, regardless of generational status.

These findings were unexpected as they do not line up with existing research on first-generation college students' access to social capital; this could potentially impact future research on the UMS campuses. The data indicated that the majority of pre-service teachers report high levels of social capital regarding university supports - translated into having people at the university who can help with schoolwork, comfort in asking professors for help, knowing how to access tutoring, and feeling they can trust people at their university to look out for their best interests. When asked if they had people at their university who could help with schoolwork if they needed it, 82% responded yes, 3% responded no, and 15% indicated they weren't sure. This leads to some important questions. Do first-generation college students studying to be teachers at other university systems report this level of support? Is there something different happening on the University of Maine System campuses? It should be noted that students (regardless of generational status) who attend UMS campuses feel well-supported and report having access to the tools required for success at post-secondary education. This is good news.

Although the majority of UMS students, regardless of generational status, report high levels of perceived social capital in regard to university supports, those students who reported not having access to social capital on their campuses reported being more mathematics anxious (both *learning* and *testing*) than their peers who reported having such access. These findings suggest social capital in regard to university supports is very important to students and their success in mathematics courses and could also support their success in post-secondary education in general. This finding is supported by the findings of Moschetti & Hudley (2005), Mean & Pyne (2017), Chang et al. (2019), and Almeida et al. (2019).

Students who report not having anyone at home who can help with mathematics do *not* have higher *learning* or *testing* mathematics anxiety than those who report having someone at home who can help with mathematics, and the effect does not vary by generational status. Again, this could be due to increased university supports for students. A study that investigated the effect of incorporating mindfulness and growth mindset intervention into a required college statistics course indicated reduced mathematics anxiety and increased mathematics efficacy in students (Samuel, T. S. & Warner, J., 2019). This suggests university-level support and access to resources is effective in reducing mathematics anxiety.

Although these findings indicate no significant generational difference, the importance of providing various supports and resources to our students on campus is clear. Students who do not have the necessary support at home may still be on a level playing field with their peers if they have access to that support at their university. In contrast, students (regardless of generational status) who report not having anyone at their university who can help with mathematics report higher *learning* and *testing* mathematics anxiety than their peers. These findings are important and stress the need for continued and, perhaps, increased efforts to provide supportive resources on campus for all students, regardless of generational status.

Exploratory Analyses

Although the following analyses are not directly tied to the research questions in this study as they have been adequately covered in existing research, the findings are none-the-less important and warrant reporting as well as further discussion. The implications of the findings are crucial for teacher preparation programs and school leaders and will be discussed in the Implications section.

Mathematics Anxiety and Gender

Collected data indicate there is a statistically significant difference between both the *learning* and *testing* mathematics anxiety scores of male and female students enrolled as Education majors across the University of Maine System; female students are more anxious than their male peers. This finding is in line with previous research exploring mathematics anxiety and gender (Huang et al., 2019; OECD, 2103; Schmitz et al., 2019; Van Mier et al., 2019). This is problematic in that the majority of pre-service teachers are female and can potentially pass on their fear of mathematics to their future students. It is important for Education programs to provide appropriate resources and support systems to mitigate the anxiety many female pre-service teachers experience. Data also indicate both male and female students are more anxious when being tested in mathematics than they are learning mathematics.

Mathematics Anxiety and Age

My findings indicate there was not a statistically significant difference between the *learning* mathematics anxiety scores of students between the ages of 18-24 and their peers 25 years and older. Interestingly, there was a significant difference between the *testing* anxiety scores of students between the ages of 18-24 and their peers ages 25 and older; while *learning* mathematics impacts both groups of students' anxiety to the same degree, students 25 years and older experience less *testing* anxiety than their younger peers. The difference in testing anxiety is supported in a study by Amy Bingham Brown (2012) that indicated non-traditional-aged pre-service teachers reported higher mathematics efficacy than their traditional-aged peers.

Perhaps students 25 and older experience less mathematics testing anxiety because they are less concerned with grades than they are with learning. Perhaps the increased push for accountability and high-stakes testing is increasing testing anxiety in our college-aged students. A study by Segool, et al. (2013) suggests that elementary students report increased test anxiety on state accountability tests compared to typical classroom assessment measures. Perhaps this anxiety is beginning to transfer to all testing situations and is now showing up in our college-aged students. Further research could help answer these questions.

Mathematics Anxiety and Upper-level Mathematics Courses

Data indicated there is a statistically significant difference between both the *learning* and *testing* mathematics anxiety scores of students who have taken upper-level mathematics courses and their peers who have not taken upper-level mathematics courses. Students who have taken upper-level mathematics courses are significantly less anxious than their peers. Again, it should be noted that the *testing* anxiety scores are higher for both groups than the *learning* anxiety.

The relationship between mathematics anxiety and mathematics avoidance has been well researched (Ashcraft & Krause, 2007; Novak & Tassell, 2017; Woodard, 2004) and is not a novel finding; however, the findings are still worrisome. If mathematics anxious students continue to avoid mathematics, they will continue to struggle with the anxiety and poor performance that often accompany the avoidance. Pre-service teachers are at risk of perpetuating the mathematics anxiety cycle in both themselves and their future students if effective intervention and support are not embedded in our teacher education programs.

Mathematics Anxiety and Mathematics Performance

My findings indicated there is a statistically significant difference between both the *learning* and *testing* mathematics anxiety scores of students who self-report as performing at an advanced level in mathematics, a proficient level in mathematics, and below proficiency in mathematics. Students who self-report as demonstrating advanced proficiency score lower on the mathematics anxiety rating scale than their peers who self-report as proficient or below proficiency in mathematics. Once again, all students score higher on *testing* anxiety than they do on *learning* anxiety.

These findings also line up with previous research indicating students who are mathematics anxious avoid math and are less successful in math (Ashcraft & Krause, 2007;

Novak & Tassell, 2017; Woodard, 2004) and that their mathematics anxiety leads to poor mathematics performance (Lindskog et al., 2017). Although not surprising, these findings are worrisome. Preservice teachers who are mathematics anxious and struggle with mathematics performance are likely to pass this anxiety and poor performance on to their future students (Cook & Hurst, 2013; Beilock et al., 2009; Bekdemir, 2010; Gleason, 2013; Kelly, et al., 2020, Ramirez, et al., 2018; Whyte & Anthony, 2012), thus continuing the mathematics anxiety cycle.

Mathematics Anxiety and Mathematics Experiences

Data indicated there is a statistically significant difference between both the *learning* and *testing* mathematics anxiety scores of students who indicate they have positive feelings regarding mathematics, neutral feelings regarding mathematics, and negative feelings regarding mathematics. Students who report having positive feelings regarding mathematics score lower on the mathematics anxiety rating scale than their peers who report having neutral or negative feelings regarding mathematics.

These findings make perfect sense and illustrate the problem with the mathematics anxiety cycle. Negative learning experiences contribute to the mathematics anxiety many pre-service teachers already experience which then lead to mathematics avoidance, and the cycle continues. It is vitally important that students, both in public schools and post-secondary education, receive necessary support and intervention in order the break the cycle as early in the process as possible.

Implications

These findings have highlighted the need for mathematics intervention, both at the university level and in public schools. I will provide recommended suggestions for several stakeholder groups in this section.

Four-Year Universities

This study indicates that access to social capital is crucial to the success of post-secondary students, and attending to the unique needs of first-generation college students is no longer the sole responsibility of community colleges. In order to address the needs of the increasing number of FGCS entering four-year universities, continued (and increased) efforts to maximize all students' access to social capital must be a priority. First-year seminars should include how and where to find support for navigating post-secondary education to include tutoring services, financial aid assistance, signing up for courses, time management, opportunities for socialization, etc.

In addition, all Gen Ed (required) mathematics courses should include a focus on conceptual understanding and problem solving to help remove the "mystery" of mathematics. Tricks and mnemonic devices are effective for memorization strategies, but they do little to help students understand the predictable nature of mathematics and can actually increase mathematics anxiety. The manner in which students are assessed is also something that should be considered, due to the prevalence of testing anxiety in students. High stakes testing, such as mid-term and final exams, should be replaced with assessments that measure proficiency without increasing anxiety, possibly in the form of portfolios or projects.

Teacher Preparation Programs: More and more students matriculated in Education programs are first-generation college students and experience the debilitating effects of mathematics anxiety; teacher preparation programs need to be ready for these students in order to have the necessary supports in place. All Elementary Education majors should be required to take mathematics courses (in addition to the Gen Ed courses) that focus on conceptual understanding, problem solving, and invented strategies. Embedded supports for the mathematics sections of Praxis I and II should be incorporated to help pre-service teachers prepare for teacher certification requirements.

Mathematics methods courses should be taught by faculty who understand and appreciate the debilitating effects of mathematics anxiety in order to assist pre-service teachers in recognizing the anxiety as well as provide support and encouragement to mitigate the anxiety. Conversations around mathematics anxiety need to be incorporated into mathematics methods courses; beginning the conversation may help remove the stigma and allow pre-service teachers to address their anxiety in a safe space. Hands-on and game-based activities should be utilized to illustrate the algorithms and increase mathematics fluency. Professional development opportunities that focus on mathematics offered to local public school teachers should also be available to pre-service teachers.

Student Success Centers: Universities typically offer tutoring and other forms of student support at their student success centers. These centers need to be prepared for the increasing number of first-generation college students and the additional resources they may require. Tutors should work closely with faculty to provide relevant and supportive assistance to struggling students in particular courses, especially mathematics courses. Tutors should also offer study sessions to prepare for Praxis exams, particularly the mathematics section of the exam. Student success centers should also include intervention and support for first-generation students who may have difficulty navigating college life on their own. It may be helpful to have coping skills workshops available to students to provide additional resources and a supportive peer group when necessary.

PreK-12 Education

Mathematics anxiety in pre-service teachers doesn't begin in college; it begins to manifest in early elementary school. It is imperative that this anxiety is addressed early on to prevent the cycle from continuing. This necessitates consistent intervention and support for both teachers and students throughout all levels of public schooling, as well as the use of research-based curriculum that focuses on conceptual understanding. First-generation college students become first-generation teachers that may still be in need of the social capital resources their peers take for granted.

Curriculum Coordinators: Professional development opportunities for public school teachers should include ongoing training and support in mathematics. Many teachers with mathematics anxiety avoid mathematics and perpetuate the anxiety cycle. Systematic and supportive intervention workshops could aid struggling teachers and provide a cooperative network of reflective practitioners. Ongoing workshop opportunities that incorporate peer to peer mathematics support should be considered to allow for sharing of instructional ideas and practices, as well as take advantage of collaborative resources. K-12 mathematics curriculum should be chosen carefully to ensure there is adequate focus on conceptual understanding development.

District-wide conversations about mathematics assessment are crucial to ensure teachers are doing all they can to address the mathematics testing anxiety many students face. High stakes tests should be used sparingly, and efforts should be put in place to allow students to demonstrate mathematics proficiency in various ways. Project-based assessments and mathematics portfolios allow students to utilize real-world mathematics solutions that contribute to their conceptual understanding and reduce the anxiety of a typical mathematics assessment.

Principals: Administrative leaders should recognize the mathematics anxiety cycle and look for patterns of mathematics avoidance. Frequent classroom walk-throughs to ensure mathematics instruction is occurring consistently and effectively daily could help start a dialogue with mathematics anxious teachers; follow-up support is crucial when concerns are observed. Mathematics coaches could be called upon to observe and then provide effective instructional strategies and mathematics practices to support to struggling teachers; if districts don't have mathematics coaches, principals could encourage peer to peer support, matching strong mathematics instructors with those who have less confidence and experience. Additionally, "Math Minutes" could be facilitated during scheduled faculty meetings with a quick demonstration and practice time to ensure teachers have access to best-practice strategies on a regular basis.

Teachers who are the first in their families to achieve a four-year degree may not have professionals in their social circles with whom to discuss their mathematics anxiety and concerns. Open and honest conversations with (and among) faculty to remove the stigma around mathematics anxiety and provide necessary support are crucial, and principals should encourage and support these conversations and interventions in their schools.

Teachers: Although it is not often discussed, mathematics anxiety is something many teachers experience. Teachers who are anxious about their own mathematics competence are often uncomfortable teaching mathematics to their students and end up shortchanging mathematics instruction. They should not suffer alone, but instead, reach out for help and advice from their colleagues and administrators. This can happen through grade-level meetings, professional development opportunities, common planning periods, after-school mathematics seminars, and even informal discussions with peers. Teachers suffering from mathematics anxiety need to recognize their anxiety, talk with others about their concerns, and advocate for themselves in helping to address the anxiety as well as preventing the anxiety from negatively impacting their students. Beginning the conversation about teachers' mathematics anxiety and how to mitigate the effects is the first step in breaking the cycle.

Possible Limitations

One limitation of the study is the variability between campuses. While I hoped to gain an understanding of the mathematics anxiety that exists throughout the entire population of first-generation preservice teachers in the University of Maine System, the smaller campuses were not as well represented as the larger campuses. This was particularly true when I disaggregated the data by campus, based on the demographics of the student population. For instance, the UMS Spring Enrollment Report (2019) indicated the larger campuses have nearly equal numbers of men and women students enrolled, compared to the smaller campuses which have disproportionate numbers of women enrolled (roughly double the number of men) as illustrated in Table 43:

Table 43. Spring 2019 Enrollment Report – The University of Maine System

Headcount by Campus and Gender

UMS Campus	**Males Enrolled**	**Females Enrolled**
UM	5166	5166
UMA	1201	3225
UMF	610	1256
UMFK	391	849
UMM	247	532
UMPI	366	683

USM	3025	4514

Considering the majority of Education majors are already typically female, the smaller campuses have an even higher percentage of women enrolled in Education programs. While I don't believe this is a significant limitation, it is one I believe could have impacted the results to some degree.

Another limitation to this study is the self-reported level of social capital students expressed. 82% of the respondents report having people at their university who could help with schoolwork if they need it, 68% know how to access tutoring, 76% are comfortable asking their professors for help, and 79% feel they can trust people at their university to look out for their best interests. Overall, students know how to ask for help, are comfortable asking for help, and feel like their best interests are being looked after on the University of Maine System campuses; this translates into access to social capital in regard to university supports.

Survey data indicate students who report not having access to social capital have higher learning mathematics anxiety than their peers who report having such access. Data also indicate students who report not having anyone at *home* who can help with mathematics do not have higher mathematics anxiety, but students who report not having anyone at *school* who can help with mathematics report higher mathematics anxiety than those who do have support. These findings suggest that one of the reasons there was not a significant difference between first-generation college students and their peers regarding mathematics anxiety may be that the majority of respondents report having access to social capital on their campuses, regardless of their first-generational status. While this reflects well on our system in that students report high levels of social capital, it could potentially present a limitation to this study; perhaps University of Maine students experience more access to social capital because of programs that have been put in place to support them that students at other universities do not have access to. In that case, the data may not be generalizable.

Conclusion

This study examined the prevalence of math anxiety in first-generation pre-service teachers matriculated in Education programs at the University of Maine System campuses. The goal was to determine whether there is a disparity between first-generation college students and their non-first-generation peers, as well as whether their mathematics anxiety and/or first-generation student status is impacted by their perceived access to social capital and/or parent education.

While there was not a significant difference in anxiety scores between first-generation pre-service teachers and their non-first-generation peers, the findings did indicate a significant difference between learning and testing anxiety for all students; students are much more anxious testing in mathematics than they are learning mathematics.

Also of interest, almost half of the pre-service teachers who participated in this study were first-generation college students. More and more FGCS are attending four-year universities; it's vital that we provide the necessary support for their success.

In addition, the findings suggest a significant effect for access to social capital, regardless of generational status; students who report having access to social capital experience significantly less mathematics anxiety than their peers. The good news is that most students attending UMS campuses report having access to social capital, especially in regard to university supports.

These findings indicate the need for continued access to supportive resources for all students as well as increased efforts to mitigate the mathematics anxiety many students experience. While there may not be a generational difference in mathematics anxiety, this anxiety has the potential to negatively impact both pre-service teachers and their future students' success moving forward. These supportive resources should be available to both elementary teachers and their students to help break the cycle early on; these resources should continue into middle and high school as well as post-secondary education, especially teacher preparation programs.

This study highlights the need for additional research to determine whether these findings are generalizable to other university systems' Education programs. In addition, there is a need for future research to assess the mathematics anxiety of all students enrolled in UMS campuses (as well as other four-year universities) to determine whether there is a significant difference between the mathematics anxiety pre-service teachers and their peers studying other disciplines experience.

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APPENDICES

Appendix A: Mathematics Anxiety Rating Scale-Revised, MARS-R

PsycTESTS®

doi: 10.1037/t06004-000

Mathematics Anxiety Rating Scale—Revised
MARS–R

Items

***Factor 1.* Learning Mathematics Anxiety**

1. Watching a teacher work an algebraic equation on the blackboard.
2. Buying a math textbook.
3. Reading and interpreting graphs or charts.
4. Signing up for a course in Statistics.
5. Listening to another student explain a math formula.
6. Walking into a math class.
7. Looking through the pages on a math text.
8. Starting a new chapter in a math book
9. Walking on campus and thinking about a math course.
10. Picking up a math textbook to begin working on a homework assignment.
11. Reading the word "Statistics."
12. Working on an abstract mathematical problem, such as: "if x = outstanding bills, and y = total income, calculate how much you have left for recreational expenditures."
13. Reading a formula in chemistry.
14. Listening to a lecture in a math class.
15. Having to use the tables in the back of a math book.
16. Being told how to interpret probability statements.

***Factor 2.* Mathematics Evaluation Anxiety**

1. Being given a homework assignment of many difficult problems which is due the next class meeting.
2. Thinking about an upcoming math test one day before.
3. Solving square root problem.
4. Taking an examination (quiz) in a math course.
5. Getting ready to study for a math test.
6. Being given a "pop" quiz in a math class.
7. Waiting to get a math test returned in which you expected to do well.
8. Taking an examination (final) in a math course.

Appendix B: Demographics Questions on Qualtrics

Section 1:

What is your gender?

Male
Female
Other

What is your ethnicity?

Asian/Pacific Islander
Black/African American
Hispanic/Latino(a)
Native American
Caucasian/White
Other

What is your age?

18-24 years
25+ years

Are you a first-generation college student (neither of your parents received a 4-year degree from a college or university)?

Yes
No

What is the highest level of education your parent(s) received?

My parents didn't graduate from High School
High School Diploma
2-Year College Degree
4-Year College Degree
Master's Degree
Doctoral Degree
Not Sure

Which university do you (primarily) attend?

University of Maine at Augusta
University of Maine at Farmington
University of Maine at Fort Kent
University of Maine at Machias
University of Maine at Orono
University of Maine at Presque Isle
University of Southern Maine

What is your major?
- Elementary Education
- Secondary Education

Section 2:

Do you have people at home who can help with schoolwork if you need it?
- Yes
- No
- Not Sure

Do you have people at your university who will help with schoolwork if you need it?
- Yes
- No
- Not Sure

Do you know how to access tutoring at your university?
- Yes
- No
- Not Sure

Are you comfortable asking for help with schoolwork from your professors if you need it?
- Yes
- No
- Not Sure

Do you feel you can trust people at your university to look out for your best interests?
- Yes
- No
- Not Sure

How would you rate your involvement in campus events/activities?
- Very Involved
- Somewhat Involved
- Minimally Involved

Section 3:

How would you describe your experiences with math?
- Positive
- Neutral
- Negative

How would you describe your math performance?

Advanced Proficiency

Proficient

Below Proficiency

Have you taken any advanced math courses such as calculus or trigonometry?

Yes

No

BIBLIOGRAPHY OF THE AUTHOR

Wendi Malenfant was born in Aroostook County, Maine in 1970. She was raised in Mars Hill, Maine and graduated from Central Aroostook High School in 1989. She attended the University of Maine at Presque Isle and graduated in 1993 with a Bachelor's degree in Elementary Education with a concentration in Health. Wendi received her Master's degree in Educational Leadership from the University of Maine at Orono in 2011. She taught in the Presque Isle school system for 17 years and served as Easton Elementary School Principal for five years. During this time, she and her husband raised their two daughters. In 2015, she accepted the position of Assistant Professor in the Education Program at the University of Maine at Presque Isle and began working toward her PhD in 2016. She was granted tenure and promotion to Associate Professor at the University of Maine in Presque Isle in 2021. Wendi is a candidate for the Doctor of Philosophy degree in Educational Leadership from the University of Maine in August of 2021.